SCIENTIFIC LITERACY AND THE ONTOLOGY OF SCIENCE EDUCATION:

A CASE STUDY OF LEARNING IN THE OUTDOORS

by

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DISSERTATION ABSTRACT

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This dissertation seeks to articulate a framework for critiquing and reconstructing science education by fleshing out the relationships between science education, its ontological commitments to nature, and educational practices that promote justice and democracy. Drawing on theoretical and methodological resources from American Pragmatism and science studies, I offer a case study that evokes the practices of a residential outdoor science program in the Pacific Northwest. I suggest that these practices provide an opportunity to imagine how science education emerges differently when it abandons its commitments to a singular and authoritative Nature, and explore how this program provides empirical resources for building a theory of science education that is multinatural. Grasping the plurality of nature diminishes the tension between experiences and the world, recognizing the importance of the sciences to democratic action without positioning them as a singular source of authority. Multinaturalism then becomes an orienting concept for imagining and reconstructing more democratic and just practices of science education, practices that move away from the transmission of a cannon of white, Eurocentric knowledge, and towards the navigation of problems in dynamic worlds.

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CHAPTER I

INTRODUCTION

My dissertation project began with a desire to engage in the ongoing debates about the purposes of science education. While such purposes and aims may at times feel far removed from the daily practices of science education, they have occupied a great deal of my thoughts and actions since first becoming a science educator, teaching middle school science in the Rio Grande Valley of Texas more than ten years ago. Fresh out of college with an undergraduate degree in biology, and a short five week training program through Teach for America, I often wondered what I was hoping to accomplish as I introduced students to topics like cells and planets and weather and the cycles of matter and energy. The answer I came to most readily involved the typical tropes of college and career readiness: science education is framed as both a necessary component of higher education in general, and the production of future scientists in particular. However, both my personal experiences with science education and the context of my students' lives called these ideas into question. My degree in biology, it turned out, indicated neither a readiness or a desire to be a scientist, and a common narrative suggesting that fewer than 40 % of the eighth grade students I taught would graduate from high school, called into question the tacit assumption that education is a means to some future success defined by norms of white, middle class America. I felt that there was an importance to teaching all students science, even those who might not have the opportunities to pursue higher education or careers in science, but I felt unable to put that importance into words.

I remember one particular incident that took place a month or so into my first year as a classroom teacher. I was sitting at the front of the room, perched next to the

overhead projector, attempting to teach my students how to use the periodic table to construct Lewis dot diagrams of atoms. Such diagrams display the number of electrons in the outermost orbit of an atom, and thus can be used to predict and make sense of the ways that atoms interact with one another and form bonds. The classroom lights were off, and I think the spectacle of my earnestness alone kept students somewhat engaged and focused on the bizarre combinations of letters and dots I was drawing. In hindsight, the idea of teaching Lewis dot structures in eighth grade science sounds pretty ridiculous, but it was what I knew how to do. And, if any of these students wanted to pursue science in college, this skill would certainly be important, or so I told myself at the time.

I looked out at the sea of faces, disinterested at best and dejected at worst, and was excited to see a hand go up. The student raising his hand was a bit of a class clown, but he also seemed to genuinely like science, and I hoped that his question or comment might help break the tension that was building in the room. Instead, he said this: "Sir, come on. Look around the room! We are Mexicans, and we are never going to need to know any of this!"

Suddenly, the attention of every student was squarely directed at me, waiting to see how I would handle this provocation. And I was silently stunned. The meager five weeks of training I had received earlier that summer from Teach for America had hammered home nothing more than a motto of "high expectations." That is, we were told that well-intentioned teachers around the country inadvertently maintained the achievement gap by holding poor students and student of color to lower expectations than their white and affluent counter parts. This was the danger of self-fulfilling prophecies, and in the face of this predicament, Teach for America teachers would challenge the

status quo by holding all students to high expectations! Were the diagramming of Lewis dot structures not part of such high expectations? And yet, what did it mean to hold all students to high expectations, to tell them all that they could and should go to college, when I also found myself playing this terrible game of looking out at my classes of students, and wondering which twelve out of the class of thirty would make it through high school? I certainly didn't want to discourage my students from going to college, and keeping this possibility open felt like an important goal, but surely, education was about more than some vague promise of future academic success, right?

I discovered several years later, while teaching advanced biology courses to affluent white students, nearly all of whom would go on to attend four year colleges, that the notion that science education was about preparing students for careers in science, or success in college science classes, continued to feel hollow. And, during the past five years of reading and thinking deeply about issues of equity and justice in education, I often struggle to articulate a compelling aim for education in general, and science education in particular. Indeed, the ubiquity of school's function as a sorting mechanism, and one that works to reproduce, rather than challenge, social inequality, leaves me wondering how the scholarship of education can do anything more than perpetuate or critique this flawed system.

Importantly, my work as a doctoral student has also taught me to be skeptical of the seductive logic of either/or thinking (Dewey, 1997). And while I recognize the importance of critique, especially in terms of clarifying and redirecting the taken for granted assumptions we carry about the roles of social institutions like education, it alone feels necessary but insufficient. Or as Bruno Latour (2004b) suggests, in the present

moment there is a pervasive feeling that critique has run out of steam. The insufficiency of critique is not merely a philosophical position; it also reflects the dilemmas I faced as a practicing educator, dilemmas that failed to dissipate even and perhaps especially when all available options felt similarly problematic and prone to critique. However compelling the critiques of education may be, they don't always offer us methods for navigating dilemmas like the one I describe above. There are innumerable students who will be attending school tomorrow, and I remain convinced that we can do better than we are currently managing, especially for populations who have rarely if ever been adequately served by the realm of public education. However flawed it might be, education remains both a gate keeping mechanism, and part of the promise of a democratic society that can work towards addressing the pervasive problems of the present. Moreover, I remain convinced that the sciences, like education, remain inextricably entangled with our daily lives. And so, perhaps more than anything else, this dissertation is an opportunity for me to continue to engage a vexing dilemma: what does science education have to do with democracy and social justice?

Framing the Problem

On the one hand, scholars like Sandra Harding (2006) discuss the role that the sciences play in both reproducing and resisting inequality, tracing the historical connections between science, colonization, white supremacy, and patriarchy. Bruno Latour (2004a) adds to this discussion a particular way by which conceptions of Science and Nature are intertwined with our politics and social world, and in particular the maintenance of a power system by which the objective truth of Science is forever able to

short circuit and override the subjective discussion of socio-political assemblies. That is, scientists alone have access to Truth, and that Truth will forever override the careful negotiations required of democracy.

Surely, then, science education is also deeply entangled in this unequal distribution of power. When we imagine that the goals of science education require that we select a few worthy individuals from the masses, and entrust them alone with the responsibility of speaking for the objective world of nature, it is hardly surprising that the larger forces of white supremacy, patriarchy, and heteronormativity determine that process of selection. Just as the work of Jean Anyon (2006) reminds us how schools provide access to different types of curriculum based on socio-economic status, training students from working class backgrounds to form the habits necessary for blue color work, while elite schools train upper class students to be critical thinkers and leaders, we should also be wary of the ways science education has been inequitably distributed to students on the basis of class, race, gender, ability, language, and nationality. In other words, if education serves to reproduce and maintain particular power differentials, it is hardly surprising that part of this maintenance requires that marginalized groups be denied access to the socially powerful knowledge of science. So perhaps we might wonder why we shouldn't just quit science education altogether.

On the other hand, I fear that we *have* begun to quit science education altogether. When we look at the contemporary political landscape, and especially those spaces and topics where science and the social most obviously mix—global climate change, vaccinations, organic foods, GMOs, fluoridation of water, etc.—it appears that groups on all sides of political spectra show a disillusionment and an unwillingness to trust the

authority of science. And while that sense of distrust is perhaps understandable, I find it equally undesirable. So the question I ask is, how to bring the sciences and science education into democracy?

Purpose

Education is a storied affair. In the present moment of rapid global communication, there is a tendency for our stories to become particularly homogenous and codified as common sense. Those homogenized stories tend also to be hegemonic, told from the perspective of those in the majority, those with power. These single stories are dangerous (Adichie, 2009), particularly to those whose own stories do not fit the sanctioned common sense. Further, these stories tend to simplify complex phenomena, tempering the multifaceted and entangled problems of the present so that they fit the offerings of universal solutions. Our stories about the problems and possibilities of science education in the United States have been dominated by several different themes: that the way science is taught in schools does not reflect the work of "authentic" science (see Atkin & Black, 2003 for a historical overview; and Capps, Crawford, and Constas, 2012 for a recent review of research on the topic); that our science education is failing to prepare citizens to compete in a social order increasingly dominated by technology (Rudolph, 2002); and that science education often fails to meet the needs of diverse learners (Lee & Buxton, 2010).

Academic research is complicit in the maintenance of these single stories, but can also serve as a form of resistance. One such form of resistance is critique, and another is the telling of different stories. My dissertation research offers a set of stories about

science education that emerge from an empirical study of a residential outdoor school (ODS) program, stories that both intersect with and push beyond the themes described above. In particular, the stories I tell challenge the tendency to equate science teaching and learning with the transmission and memorization of a specific body of canonical knowledge. Instead, I argue that the science education that unfolds in this ODS offers a case study for thinking differently about the important connections between science, education, and democracy.

As the anecdote I offer at the beginning of this chapter attests teaching science, like teaching in general, is full of dilemmas and uncertainty, requiring teachers to navigate tensions, to make decisions and choices that open up some possibilities while foreclosing others. The goal here is not to lessen that uncertainty, or to provide a prescriptive teaching method that settles those decisions in advance. However, I argue that teachers should be able to articulate the positive aims of their crafts, and should have access to multiple frameworks and orienting principles for guiding their work. Theories of social justice in education (eg. Apple, 2010), of anti-oppressive education (Kumashiro, 2000) and culturally relevant pedagogy (Ladson-Billings, 2014), can offer such guidance. Yet, in working to prepare future science educators, I have found that individual's preparation in the disciplines of the natural sciences often provokes tension with these terms. These future science educators ask—often implicitly and sometimes out loud—what does *social* justice have to do with the *natural* sciences? How can science, as a universal way of knowing, be made *culturally* relevant? On the one hand, I acknowledge that part of my work as a science educator is to demonstrate precisely why these frameworks are not only relevant to science education, but necessary components of

pedagogical and curricular practices that are equitable and rigorous. On the other, I believe that the field of science education needs to develop specific frameworks and orienting principles for guiding its practice. Just as Shulman's (1987) concept of *pedagogical content knowledge* urged educators to recognize the specificity and nuance required to effectively teach within different disciplinary spaces, I argue that scholars and practitioners of science education must identify both the specific obstacles that their subject matter can impose on the aims of justice and democracy, as well as strategies and principles for overcoming them.

I conceive of this work as an act of diplomacy. The point is not to position the practices of this ODS as inherently good, and those of more traditional manifestations of science education as inherently bad. Instead, I suggest that these practices provide a site of inquiry to think both empirically and theoretically about the particular ways that science education can both encourage and stymie democratic action. That is, I think the practices of this ODS program, and the stories I tell about them in this project, offer resources for thinking and doing science education differently, resources that up to this point have not been given an opportunity to engage in the broader conversation about the aims of science education. Such an engagement is not facilitated by the valorization of one version, enactment, or collective of science education at the expense of another. As Latour (2004a) suggests, we have all too often positioned one collective as civilized at the expense of understanding another as barbaric. Such a tendency is catching, and soon all collectives begin to envision the others as barbarians and threats to civil engagement. Instead, Latour offers this shift:

> Whereas (external) barbarians threaten (internal) barbarians with destruction, (external) civilized beings threaten (internal) civilized beings with *new*

> *requirements*. We might thus say about [the second pairing]… that it 'defends civilization,' provided that we no longer define civilization, as modernism did, by a position on the ladder of progress (there is no more ladder, and no more progress), but instead by the *civility* with which a collective allows itself to be disturbed by those whom it has nevertheless explicitly rejected. pp. 208-9

Programs like this ODS have largely been rejected from the collective of science education research, shoved into other categories like informal learning, and environmental education. This work, then, seeks to broker a conversation between ODS and the field of science education research, not simply to offer a new critique, but in the hopes of generating a theoretical framework capable of grasping the complex and contradictory relationship between science education and democracy.

Finally, there is a more practical purpose here. In November of 2016, voters in Oregon will consider a ballot measure that would provide funding for a full week of ODS for all sixth graders across the state. This is a deeply exciting development, and the ballot measure is the result of tremendous political and community efforts by stakeholders across the state, including individuals and groups associated with the ODS program where I conducted my research. Indeed, this ODS program is the longest running of its kind in the state, and will likely serve as a model for the development and proliferation of additional ODS programs that will be required if the ballot measure passes. That being said, not all outdoor residential science programs are the same, and based on several interviews I conducted with staff members who had also worked for other outdoor education programs across the country, I am increasingly convinced that the practices of this particular program are unique in several regards.

The program has worked hard to remain current in terms of the science it teaches. For example, in the fall of 2014, I attended a training with staff members led by the a

group called the Portland Metro STEM Partnership, titled "Bringing Assessment for Learning Outdoors: developing, using, and reflecting on common measures to drive program improvement." This training felt highly reflective of major trends in science education more broadly. Of equal importance, the program has also continued to be critically reflective of how it can better support the needs of diverse learners, bringing in outside consultants to review their practices through lenses of equity and anti-oppression, and encouraging sustained conversations on topics ranging from gender inclusivity, supporting learners with autism, and combatting the culture of whiteness that persists in outdoor education more broadly (see Finney, 2014; McLean, 2013). As such, the practices of this program can serve as a model for guiding the development of other outdoor school programs across the state. Of course, each region will need to create a program that suits the needs of both its geographical and demographic specificity, but I hope that presenting a set of stories that evoke the complex practice that have developed in this program over a half century may guide the development of other practices across the state.

Overview of Research Site and Method

This ODS program, which operates under the organizational umbrella of the Multnomah Education Service District (MESD), has been serving sixth graders in the greater Portland metro area since the late 1960s. I went to ODS as a student in the sixth grade, and again as a volunteer in high school where I first experimented with the possibility of being a science educator. I returned to ODS as a staff member in between teaching jobs in Texas and Oregon, and continued to support and encourage the high

school students I later taught to put their science to use by volunteering with the program. The practices of this ODS have permeated my thinking about science education, and I wanted to figure out a way to make sense of this phenomenon. That is, I wondered what exactly it was about this educational setting that seems to offer a different version of science education, one that perhaps partakes differently in the problematic dynamics I describe above.

The MESD serves eight different school districts across Multnomah County, specializing in alternative education services that support students with special needs and those who have been unsuccessful in traditional school environments. This orientation has been important to this program's development, shifting it away from what the current program director called "a Boy Scout model of assimilation," and towards an "ethos of accommodation". This outdoor school serves classes of sixth grade students in overnight camp settings, where students from four different middle schools come together at one site to engage in hands-on learning about the natural resources endemic to forests in this region of the Pacific Northwest. The program runs every fall and winter, serving students at multiple sites. Historically, the program operated six different sites, providing all students with a six-day, five-night learning experience. Over the past five years, budget cuts forced the program to slim down to three sites, and during the 2014-2015 school year, most students attended a three-day, two-night condensed program. This past fall of 2016, the program has expanded back to five sites, and once again offers most students a full six-day program.

Each site is operated by eleven permanent staff members, and each week, these permanent staff members are joined by a group of between twenty and thirty high school

volunteers, known as student leaders. The eleven permanent staff members have particular titles and responsibilities, which I describe below:

- one site supervisor, who is both the visible leader of each site and the person responsible for much of the administrative and organizational tasks that keep the programs running smoothly;
- four field instructors, who are responsible for developing the science curriculum and training the high school student leaders to deliver the curriculum to groups of sixth grade learners;
- six program leaders, three who identify as male and three who identify as female, who are responsible for the non-instructional aspects of the program, and in particular training and supporting the high school student leaders in the areas of leadership and community development. Four of the program leaders are also responsible for assisting on each of the field studies, and the remaining two are responsible for coordinating efforts to support students with special needs.

Staff members live in small cabins on site, and arrive every Sunday at noon, and depart on Friday afternoons for brief weekends of rest.

While many residential outdoor science programs exist across the country, the role of high school students with this program makes it very unique. In addition to leading the majority of the instructional activities, the high school student leaders are responsible for overseeing one cabin group in the case of the weeklong program, or two different groups during weeks that run two short programs. The sixth grade students from the four different middle schools are mixed into cabin groups, where typical weeks involve six cabins for male identifying students, and six cabins for female identifying

students. I use the language of gender identification intentionally, as this ODS program explicitly invites sixth graders, high school student leaders, and staff members to recognize the difference between biological sex and gender identity, and has a history of accommodating gender-creative individuals at all levels of the program. Each cabin typically houses between eight and ten sixth graders and one or more student leaders. While program leaders are responsible for supporting high school student leaders in the cabin area, the student leaders are responsible for getting the students to bed at night, waking them up in the morning, and delivering them on time to many different locations in the tightly packed daily schedule.

Student learning is organized thematically into four different field studies, addressing how multiple scientific disciplines enhance our understanding of water, soil, animals, and plants. During the weeklong programs, students spend one day learning about each of the four field studies, including a period of about three hours each before and after a break for lunch. During the three-day program, students spend a half-day on each field study. During field study, students work in small groups, typically 3-6 students, and the curriculum is organized around stations or hikes, and engages students in practices and techniques that enable them to measure, name, and describe components of healthy ecosystems, and to explore how such knowledge can be used to guide the decision making processes of humans as they interact with their environment.

While the half-week sessions are clearly a different learning experience, this shortened time did mean that during the course of my field investigation, I was able to witness over 25 iterations of the program, serving around 100 different classes of sixth grade students. This iterative nature enabled me to pay careful attention to the different

ways that this program is able to serve the needs of diverse and varied learners and learning styles. The half week sessions were also interesting in that they provided the high school student leaders with two different opportunities to practice their skills of teaching and community building.

In the fall, I acted as a participant observer, and lived full time on site from noon on Sunday until Friday at five each week, and I experimented with multiple ways of being and interacting with both the staff and the learners involved. The program is interesting in terms of its compartmentalization: staff members are typically involved in the teaching of only one of the field studies, and share other jobs so that there are not always many opportunities for staff members to witness the work of each other, or to understand how the lessons being taught in one field study interact with the others. Realizing what a tremendous gift it was for me to be able to move freely through the program as a researcher, I spent the last two weeks of my fall observations returning this gift in kind to the four staff members directly in charge of the field study portion of the learning, taking over each of their jobs for a half week session, allowing that individual to be the researcher for the week. Our debriefs after their experience became an integral part of my field notes. This process also reminded me of just how situated our knowledge is and how important it would be for me to conduct interviews with a wide swath of the program's participants in order to begin to understand precisely how the program works.

In the spring, I continued to live on site, and shifted from a focus on field notes to an emphasis on interviews. Over the course of the spring, I conducted 15 group interviews with high school student leaders (n= 60), and 12 individual and group

interviews with staff members across the three sites in operation last year (n= 22). Importantly, while I was unable to interview the sixth graders directly, nearly all of the high school volunteers had themselves been sixth graders involved in the program, and spoke both of their experiences as SLs and as students.

My experience in the field shifted my thinking about science education, and the relationship between its aims and the work of promoting justice and democracy. My initial interests revolved around efforts to redefine scientific literacy. Scientific literacy, and its articulation as a broad goal in science education, seems to hold the promise of a more expansive notion of the purpose of science education. It has the potential to recognize the role that science plays in collaboration and democracy, and might work against definitions of science as a set of stable facts and concepts. At the same time, scientific literacy has historically been conflated with the memorization of scientific content, and as long as scientific literacy remains wedded to conceptions of knowledge transmission, it misses both the complexity of the sciences as a diverse set of socio cultural practices, and the ways in which science education maintains particular problematic distributions of knowledge and power. Much work has been done in the last 15 years by scholars looking to redefine scientific literacy with a focus on the sociocultural importance of this construct. Wolf-Michael Roth and Angela Calabrese Barton's (2002) text *Rethinking Scientific Literacy* marks an important contribution, and the work of Michel Van Eijck (2012) turns to the field of science studies in order to argue that we must understand scientific literacy as an emergent feature of collective group activity. This definition is compelling to me, but I argue that it is also vague– many things are emergent features of collective group action.

Moreover, I became increasingly interested in the relationships between science education and the nature that it purports to study. While scholars of science education have been increasingly attentive to the epistemological aspects of science education—what is often referred to as the Nature of Science—ontological concerns have been largely ignored. This is particularly salient to my project, as the work of Harding (2006) and Latour (2004a) suggests that the anti-democratic tendencies inherent in modern science stem largely from a particularly metaphysical orientation, what Harding refers to as the "unity of science thesis," and Latour recognizes as mononaturalism. Accordingly, I began to think about this ODS as a set of practices that enabled learners to renegotiate their relationships with both nature and culture, and began to wonder what scientific literacy would look like if students were not being directed towards understanding a single nature, but rather a multiplicity of natures that are always in the process of being remade, of becoming differently.

Research Questions

In this dissertation, I consider the following research questions:

- How has the field of science education research framed and investigated the relationship between science education, justice, and democracy?
- How can the field of science education generate specific frameworks for surfacing both the disciplinarily specific obstacles that their subject matter can impose on the aims of justice and democracy, as well as strategies and principles for overcoming them?
- How can the practices of MESD ODS serve as a case study for developing a theory of scientific literacy that is both collective and multinatural?

- How does a reconceptualization of scientific literacy, away from the transmission of knowledge and towards multinaturalism and collective action, strengthen the ability of science education to support the aims of justice and democracy?

Through considering these questions, I hope to provide science educators and policy makers with a different means of exploring the relationship between science education, justice, and democracy. By focusing on the concrete practices of an ODS program, I hope to offer a theory of multinatural scientific literacy that is both philosophically and empirically informed. Such a theory of scientific literacy may offer science educators, including both practitioners and those responsible for preparing future science teachers, novel methods for both problematizing current practices and policies, as well as imagining new ones that further the work of teaching towards a more democratic and just future.

Outline of Chapters

In chapter two, I briefly detail the history of science education in the United States, investigating how competing curricular orientations and different conceptions of the social aims of science education have influenced policy reform and scholarship in general. I argue that the field of science education research has recently demonstrated increased reflexivity, but that such reflexivity has largely addressed the epistemic aspects of science education. In doing so, the scholarship and practice alike have largely ignored the ontological commitments of science education, commitments which engender a problematic relationship between science education and democracy. In order to address this lack, I turn to the field of science studies, and the ontological politics of Bruno

Latour (2004a), in order to begin to imagine an articulation of scientific literacy that coheres with an ontology of multinaturalism.

In chapter three, I describe my methodological approach, which centers on the pragmatist reconstruction of experience and the emphasis in science studies on case study and ethnographic work that blurs the boundary between data and theory. I explore John Dewey's (1981) theory of experience, and examine how the distinction he makes between knowing and having an experience influenced my efforts at designing a pilot study that would enable me to attend to more than the cognitive dimensions of the ODS program I set out to investigate. This pilot study encouraged me to focus the subsequent portion of my research on interviewing both the staff members and the high school student leaders, and also led me to theorize ODS as a "being of metamorphosis" (Latour, 2013), which enables students an opportunity to renegotiate their relationship with external reality, including components we traditionally categorize as both cultural and natural.

Because my methodology seeks to value the complex experiences of my research participants, and not just their cognitive dimensions, I seek to evoke the practices of this ODS program through a series of short stories. I frame these stories as "beings of fiction" (Latour, 2013), and describe the implications of this framework in chapter 4 before presenting the stories themselves. In chapters five through eight I present these stories. Chapter five details the events that occur when a new group of students arrive on site, underscoring how this ODS program explicitly emphasizes both the importance and difficulty of building new communities. Chapters six and eight offer stories of the science learning that occurs during the four different field studies, while chapter seven

further emphasizes the work of community building that occurs throughout each program.

Finally, in chapter nine, I draw on these stories to construct a more robust and concrete theory of multinatural scientific literacy, starting with a brief vignette of my experiences teaching science in a traditional classroom setting as a counterpoint. I then briefly outline the implications of this work, and directions for further inquiry.

CHAPTER II

LITERATURE REVIEW

I envision the literature review as an opportunity to enter into a conversation about the aims of science education. This is a conversation I joined as a new science teacher over ten years ago, and one I continue to participate in as I work to support the development of a new generation of science educators. In particular, I am driven by practical concerns that have swirled around these identities—what is the relationship between science education and democracy? Between science education and social justice? I recognize that these questions are huge in scope, and could be investigated by pursuing innumerable paths of inquiry. Indeed, the choice to locate my dissertation research within the practices of a residential outdoor science education program may appear to fit more squarely within topics like environmental education or place-based education. However, I contend that as the field of science education research continues to seek novel means of problematizing and reconstructing the aims of science education, the practices that lie on the periphery should not be ignored.

This literature review, then, continues the work of diplomacy that I set out in the introduction. While I will examine the aims of science education with a critical eye, the point of this work is not simply to denounce mainstream science education and the research that drives it. Instead, I want to explore where and how the field of science education has shifted, and also point towards facets of science education that have remained relatively under-theorized and uninterrogated.

Scholars of science education and science studies have debated the conceptual knowledge that science education should attempt to convey, and have shown increasing

attention to both the epistemology of science, as well as the diverse ways that the sciences come to matter in the lives of individuals and communities. The epistemological practices of science, or the ways in which scientific knowledge is produced, vetted, and disseminated, are referred to as the nature of science; the ways that this knowledge comes to matter for individuals and societies is often framed by the notion of scientific literacy. That both the nature of science and the concept of scientific literacy are increasingly subject to scrutiny within the field is an important indication that science educators are dissatisfied with aims of science learning that focus on the transmission of static content alone.

On the other, while conversations about the conceptual, epistemic, and social aims of science education become increasingly nuanced, discussions about the ontological underpinnings of science education remain relatively absent. First, I recognize a tacit assumption that when we speak of science education, we are in fact talking about the *natural* sciences, as the social sciences have been subsumed within a different disciplinary space. This distinction, while not entirely the topic of this project, is important nonetheless. Moreover, I argue that even when it is clear that science education focuses on the natural sciences, rarely if ever do we interrogate the following: what is the nature of *nature* that the sciences purport to study in the first place? At first glance, this may not even seem like a question worth considering; isn't the answer in the question itself? Surely, scientists study nature. Enough said.

However, I argue that the certainty with which we answer this question is precisely the problem. While science educators and researchers of science education have attended to the epistemological and social implications of the sciences, they largely

ignore the ways in which our modes of inquiry into the world are always already shaped by conceptions of what counts as nature, and the relationships between humans and nature more broadly. Importantly, I will argue that a particular and largely taken for granted conception of nature continues to adhere to the sciences, and that this ontological framework is responsible for perpetuating habits and principles that prevent the sciences, and science education, from being compatible with the larger aims of democracy and social justice.

Competing Curricular Aims and a Singular Nature

Since its inception in the latter half of the nineteenth century, science education has been the site of vigorous debates— debates about the material that should serve as curriculum, about the proper pedagogical methods for delivering science curriculum, and about the social aims of science education more broadly. Scholars of education and scientists alike have developed increasingly sophisticated frameworks for thinking about the production of scientific knowledge, and how to teach and learn both the conceptual and epistemic dimensions of science. Consequently, science education as encoded in policy documents has shifted. For example, the Next Generation Science Standards (NGSS) exhibits significant departures from earlier attempts to define and standardize the curriculum, especially concerning the epistemology of science. Gone is the ubiquitous talk of inquiry and a singular scientific method, and in its stead a set of eight interrelated science and engineering practices.

At the same time, I argue that throughout the procession of these reforms there remains a taken for granted feature of science education curriculum and pedagogy that

has remained largely static, and one that is deserving of greater scrutiny. While debates have raged about the nature of science and its social importance, the nature of nature itself, the phenomenon towards which scientific knowledge is directed, has been relatively ignored. In other words, contemporary science education has become increasingly reflexive about both the epistemic and social dimensions of learning and teaching science, while continuing to operate with an ontology that would be all too recognizable to eighteenth century scientists and philosophers like Newton and Descartes.

During the latter half of the nineteenth century, the study of science sought a contested spot in school curriculum, seeking to replace the classical study of language in order to shift education away from its sole emphasis on mathematics and the humanities. In particular, advocates like Thomas Huxley, Herbert Spencer, and Charles W. Eliot emphasized the importance of supplementing the deductive and authoritarian learning of mathematics and language with what they believed to be the exploratory and inductive nature of science. Drawing inspiration from Swiss educator Johann Heinrich Pestalozzi and the philosophy of Jean-Jaques Rousseau, Huxley, Spencer, and Eliot derided the use of textbooks as pedagogical tools in science instruction, and insisted "[i]t was the direct contact with the objects and phenomena of nature that made science a unique subject in the curriculum and justified its presence as a disciplinary subject" (DeBoer, 1991, p. 48).

Nature was also central in configuring the social role of science, and during the early twentieth century, the popular approach to science education was called "[n]ature study and was created to address what was seen as a serious social problem: urbanization" (Atkin and Black, p.4). This program of study was fueled by the College

of Agriculture at Cornell University, and its explicit aim was to instill in children a love of nature, a love that life in cities seem to put in jeopardy. Here, we see the origins of a pervasive curricular orientation in science education often referred to as the Discovery-Inquiry model (Duschl, 2008). Nature is understood as both the object of science education, and its most effective teacher. Students are encouraged to engage in guided practices of inquiry, allowing them discover the laws of nature, rather than simply memorizing them as a set of discrete content.

This version of science education meshed nicely with the larger ethos of progressive education circulating during the first half of the twentieth century, marked by a renewed critique of traditional educational methods that relied heavily on rote memorization and recitation. However, even while progressive ideals characterized the vast majority of research and scholarship on the teaching of science in the period of time leading up to the Second World War, the lack of coherency and self-governance among educational researchers left the field of curriculum a contested space. In particular, the utility of the Discovery-Inquiry approach became increasingly questioned as educational researchers and university scientists alike were largely unconvinced that classroom teachers were able to abandon the ubiquitous practice of lecture. In other words, teachers were positioned as obstacles to student learning, obfuscating the access to nature required by the Discovery-Inquiry model, and evidence of such skepticism is clear in numerous observational reports by educational scholars and researchers during this era (DeBoer, 1991, pp. 74-83).

Accordingly, this progressive era also contained the seeds of what Kliebard (1995) refers to as the "bureaucratization of the American Educational enterprise" (p.81)

that developed in the wake of World War II. Lagemann suggests that just as the utility of psychology during World War I helped establish its revered status in the 1920's and 1930's, the popular perception that physics brought victory in World War II had similar consequences regarding the role of the natural sciences in determining policy issues (2000, p.160). The wartime efforts of the National Science Foundation (NSF), which emphasized the utility of gathering groups of expert scientists from a variety of disciplines to collaboratively determine the solutions to complex problems, became the model for newly emerging efforts to define and determine science curriculum (Atkin and Black, 2003, p.30-34). However, the increasing divide between the academic design of curriculum and its implementation by practicing teachers remained a problem. Scientists remained highly critical of the teaching they observed in classrooms, and "some scientists proclaimed that henceforth they had to concentrate on 'teacher-proofing' the curriculum" (Atkin & Black, 2003, p. 37).

This led to a second major curricular orientation in science education, one often referred to as the Content-Process approach (Duschl, 2008). If teachers were unable to facilitate the nuanced relationship between students and nature required of the Discovery-Inquiry approach, they could at least transmit the knowledge that scientists had ascertained from nature themselves. Accordingly, students are asked to memorize sanctioned scientific knowledge, and to engage in cookbook style laboratory activities that mimicked the techniques scientists used to coax nature into revealing its immutable laws.

While the design of science curriculum content—the actual body of knowledge that was to be taught—remained in the hands of scientists engaged in the natural

sciences, efforts to define the *process* of science that should be taught in the curriculum were led by task-analytic psychologists like Robert Gagné (Atkin & Black, 2003, 130-132). This work strongly resembled the administrative approach to general curriculum design ushered in earlier by Taylor's factory model of efficiency, and Gagné and others attempted to identify the discrete tasks that working scientists relied on in their work. The results were the reductive and linear process that characterizes *the* scientific method (TSM) taught in schools today, as if science proceeds by some singular progression of events, from the formulation of hypotheses, the collection of data, and the drawing of neat and tidy conclusions. Importantly, as Atkin notes: "Scholars in the fields like philosophy, history, and the sociology of science, who often take a more nuanced view of the scientific enterprise, were not consulted" (Atkin & Black, 2003, p.131).

Despite significant critiques of both the Discovery-Inquiry and the Content-Process models of science teaching and learning, these orientations continued to dominate the teaching of science throughout the second half of the twentieth century. Moreover, while these two curricular orientations are clearly different in their formulations of teaching and learning, I argue that they position nature in ways that are strikingly similar. That is, while the two orientations suggest different approaches to knowing nature, the ontological understanding of nature itself remains the same. In both, nature is singular and uniform. That is, the Discovery-Inquiry approach works because the laws of nature are so stable and self-evident that, given the right tools and techniques, students can discover them. And the Content-Process approach works because, even if teachers are unable to facilitate they type of engagement with nature necessary for the discovery of its immutable truths, they can at least transmit those truths, and introduce

students to the particular processes by which mute nature can be made to speak. The differences between these two orientations are important, but are largely epistemic. In other words, the Discovery-Inquiry model may position nature as more readily knowable, and accessible to a larger audience, both hold onto a conception of nature as singular, where science is tasked with providing an accurate representation of this stable phenomenon.

Shifting Social Aims and Critical Voices

During the second half of the twentieth century, while the Discovery-Inquiry and Content-Process approaches to curriculum and pedagogy continued their tug of war for supremacy, the social aims of science education shifted drastically. If the study of nature was unable to stem the tide of urbanization, it might at least ensure that the United States remain competitive in the newly emerging world order. In the late 1950's, the Soviet launch of Sputnik would usher in a new reform movement in science education, and one that continues today. Scholar of science education Richard Duschl (2008) refers to this reform movement as the economic imperative, as it locates the importance of science education in terms of global economic and military competition. As the title of Rudolph's (2002) book-length treatment of the topic suggests, this era sought to make *Scientists in the Classroom*. These efforts were explicitly aimed at constructing a "pipeline" that would direct those students with natural ability in the sciences towards careers where their aptitude would help ensure the United States its place at the top of the world order. Accordingly, science education focused on "talent selection," and while these aims are often described as possessing an economic orientation, they are also inextricably intertwined with larger conversations of global security.

In the 1980's, the prevalence of this "economic imperative" was challenged by a "Science for All" movement, where the "education goal was and is to develop a scientifically literate populace that can participate in both the economic and democratic agendas of our increasingly global market-focused science, technology, engineering, and mathematics (STEM) societies" (Duschl, 2008, p. 268). Rather than an abandoning of the previous economic imperative, this effort attempted to expand the goal of science education beyond the selection of talent, and towards the development of a population able to engage democratically in a world increasingly intertwined with scientific and technological problems and possibilities. On the one hand, the explicit attention to the relationship between science education and democracy is exciting, and has opened up new perspectives and approaches to interrogating how science education is complicit in both resisting and reproducing social inequalities. On the other, I argue that this growing literature has primarily addressed the relationship between the social aims of science education and the epistemic dimensions of science. That is, these forces have led to a multicultural awareness in science education, recognizing how different cultural traditions come to know the world differently. The world itself, however, continues to be treated as a singular and uniform phenomenon.

The last several decades have witnessed a proliferation of critical, multicultural, and sociopolitical frameworks across the field of education research (Lagemann, 2000). Scholars working within these frameworks pointed to ways that science education, despite this seemingly democratic orientation, failed to adequately serve students from populations with cultural norms that differed from those of Eurocentric, elitist, and male-dominated tradition of Western science, including women, students of color, and students

of low socioeconomic status. Theories of science learning and advances from the learning sciences have also influenced how scholars and practitioners alike imagine both the difficulties and advantages of learning science in school settings. Lee and Buxton (2010) explore multiple frameworks for interrogating the intersections between science education and social justice. They begin by examining how efforts to disaggregate achievement data have revealed interesting patterns regarding the relative success of different demographic groups. However, while such research has shown that gender, socio-economic status, and racial and ethnic identities impact success on science achievement, such impacts don't follow any clear patterns across age groups. In other words, static categories like race and gender play a role, but do not determine, students' science achievement.

In addition to analysis of achievement data, much of the critical scholarship in science education has stemmed from increasingly nuanced understandings of culture, and the interactions between the culture of students and that of Western science more broadly. That is, following Thomas Kuhn's positioning of science as a culture unto itself, scholars of science education have been increasingly attentive to the specific forms of argumentation and reasoning endemic to science. This literature emphasizes how the process of learning science may unfold differently depending on students' cultural beliefs, worldviews, and discursive practices. For example, the long-running Cheche Konnen research team has demonstrated how instructional practices that emphasize open-ended practices of inquiry and experimentation can significantly shift students' understandings of the epistemic practices of scientific investigations (Rosebery, Warren, & Conant, 1992).

The fields of cultural studies and the application of sociopolitical concerns to science education have raised important critiques concerning the universalizing tendency of scientific discourse. Angela Calabrese Barton's (1998) *Feminist Science Education* explores stories from her experience teaching chemistry to working class women in a community college setting. Here, she highlights both the distance between science and the lived experience of these women, as well as the profound intellectual resources such lived experiences can offer for understanding the science that operates in our everyday worlds. Scholars have explored the relationship between Western Science and what is referred to as Traditional Ecological Knowledge (eg. Ogunniyi, 2007;Van Eijck & Roth, 2007; Van Eijck and Roth, 2011), recognizing both the differences and similarities between the methodologies of Western Science and those employed by native peoples to know the world. In addition, theories of culturally congruent pedagogy (Parsons, 2008; Tobin, 2000) have probed how the cultural and discursive structures of science often pose barriers to learning in general, and narrative case studies reveal how the cultural identity of both teachers and learners can complicate the work of science education. For example, Chang & Rosiek (2003) explores an ethical dilemma that emerges in the practice of a new Hmong science teacher working with students who share his cultural background. One of his students voices concern that learning Western science seems to necessitate an abandonment of traditional Hmong cultures and values. Importantly, while such differences may be most extreme for students who come from non-Western cultural backgrounds, Lee and Buxton (2010) suggest that even "within the cultural mainstream… relatively few children's primary socialization is so science oriented as to be perfectly continuous with the demands of school science" (p. 53).

While this literature is clearly critical of the Content-Process curricular orientation in science education, which tends to position scientific knowledge as culture free and neutral, there are also compelling critiques of the Discovery-Inquiry model. For example, Sconiers & Rosiek (2000) explore how the ubiquitous aim of inquiry in science education, which encourages students to take risks and flourish in an atmosphere without right answers. Here, an African American teacher reflects on the difficulties he experienced when using an open ended inquiry approach with African American high school students: "Their experience with science up until this point has been limited to information and worksheets. The open-endedness of my instruction is causing some anxiety." (373-4). That is, for many students, the adoption of the Discovery-Inquiry model alone is far from liberating. Additionally, Windschitl et al (2008) have argued that the Discovery-Inquiry model, which suggests that all scientific knowledge is produced by a singular procedural orientation, known as The Scientific Method (TSM) fails to adequately teach the complex and plural ways that science is practiced in contemporary society. Accordingly, the authors suggest that "TSM is not scientific at all when considered from an epistemic perspective, and that it subverts young learners' understanding of both the practices and the content of the discipline" (p. 942).

I want to emphasize that these critiques are important, and have pushed both the scholarship and practice of science education in exciting new directions. They have revealed an increasingly nuanced understanding of science as a particular set of cultural and epistemic practices. This emphasis has helped scholars of science education better understand the border crossing required when students from diverse cultural backgrounds are asked to conform to the particular structures of scientific reasoning and

argumentation, and have also demonstrated that science itself involves practices of knowledge production that depart from simplistic models of experimentation. Accordingly, Duschl (2008) announces that the field of science education should seek to balance its epistemic, conceptual, and social goals, moving away from a relatively naïve democratic imperative, and towards a cultural one, which "sees STEM disciplines, knowledge, and practices as woven into the very fabric of our nation and societies" (p. 268). In terms of policy, the Next Generation Science Standards (NGSS) have intentionally moved away from the problematic and overused notion of inquiry, and instead positions the epistemic dimensions of science as a set of eight interrelated practices.

At the same time, this emphasis on culture and epistemology has continued to ignore the way that science and science education involve particular imaginations of nature and the material world. So while a cultural imperative in science education recognizes that diverse learners may approach the world through different sets of epistemic practices, and that science itself is a distinct way of knowing the world, the world itself is singular. That is, science education may have become multicultural, but it remains wedded to a theory of mononaturalism. This too, shows up in the NGSS policy document, where, in a section that describes the Nature of Science that teachers should emphasize, we see the following claim: "Scientific Knowledge Assumes an Order and Consistency in Natural Systems" (citation?) Accordingly, science is beholden to a unity thesis (Harding, 2006), and one that continues to hierarchize ways of knowing in ways that are profoundly anti-democratic. In the next section, I will argue that the concept of *scientific literacy* provides fertile ground for carrying out this effort to harmonize the

nuanced epistemic, conceptual, and social aims of science education, while also beginning to probe the relationship between science, science education, and the ontological positioning of a singular nature. As such, I will begin to ask the question: what does it look like to teach students to become scientifically literate in a world in which nature is not singular but multiple?

Scientific Literacy and Multinaturalism

The term scientific literacy has been offered as an aim of science education since the 1980's, and during the last twenty years the term has been subjected to a variety of critiques and revisions. On the one hand, Morris Shamos (1995) suggests that scientific literacy is an impossible goal, as no more than five percent of the population ever possesses the knowledge to make adequate decisions regarding scientific matters. On the other, scholars have questioned the underlying assumptions about the relationship between science and society that adhere to traditional definitions of scientific literacy (Barad, 2000; Roth & Barton, 2004; van Eijck, 2012). Scholars in this second group argue that scientific literacy remains a compelling goal of science education, but that it must be revised by attending to the moral, social, political, and cultural dimensions of science as a set of diverse practices that inform the lives of all citizens in democratic societies. Much of this exciting work to redefine scientific literacy has drawn from the diverse field of science studies, which, owing to an emphasis on historical case studies and ethnographic analysis of science in action, has emphasized the discrepancies between science as practice, and science as representation of the world.

Historically, scientific literacy has often been equated with the transmission of the scientific knowledge necessary for competition in the global economy. In other words, the goal of scientific literacy has emphasized what an "individual needs to know or be able to do independent of the physical and social setting," where such "knowledge and skills listed are often highly technical and distinct from daily living (Roth & Barton, 2004, p. 4). According to this view, such knowledge is distilled from the objective and singular world of nature by the careful work of scientists. Defenders of the neutrality of science argue that "Nature alone, with the assistance of universally valid rational thought and culture-free research methods, is supposed to be the sole contributor to sciences' representations of nature's order" (Harding, 2006, p. 4). In this view of science, a plurality of cultures are recognized, but only as distorting influences on the purity of science's primary task: to produce an increasingly coherent and singular description of the world. Harding refers to this as the unity thesis, and suggests that contemporary thinkers like E.O. Wilson have recently rallied around this thesis in order to defend against the dangers of relativism. In response, Harding notes that the unity ideal carries with it both political and scientific costs, where science only ever speaks in a monologue, and is inherently insulated from outside critiques: The unity ideal values only coherence in scientific accounts, undervaluing the benefits of conflict and dissonance so visible in the history of science;" consequently, science's "voice of expertise is authoritarian" (p.126). Indeed, this ideal prevents a sustained critical conversation within the discipline of science itself, as all detractors become positioned outside of this ideal of unity, and thus not worthy of attention. Yes, cultural and social factors exist, but only ever as a context that distorts the purity of science's descriptions of nature. Importantly, critical

voices in science studies, and feminist scholars in particular, have demonstrated that this set of facts and principles is not neutral—there is no God's eye view (Haraway, 1988)—and that the practices and theories of science are historically entangled with racism, sexism, abelism and the socio-political supremacy of white males (Harding, 2006).

This radical separation between the elements of the sociocultural on the one hand, and those of nature on the other, prevents the harmonizing and balance that Duschl (2008) so desperately seeks. As such, scholars of education have begun to plumb the resources of science studies in order to provide an understanding of the relationship between science and society that moves away from this model of singular content within a plurality of contexts. I begin by examining one particular instance where this framework has been used to redefine scientific literacy. This effort is important, and certainly untethers the concept of scientific literacy from the problematic framing of science education as a project of transmitting a singular set of knowledge. However, I will then argue that the science education literature has failed to engage one of science studies most salient and unique features: an emphasis on what John Law (2008) calls ontological politics, and one that I suggest has the potential to better integrate science education with democratic collective action.

Scientific Literacy as Collective Human Action

> In contemporary knowledge societies, the production of scientific knowledge is unprecedented in scale and becoming increasingly reflexive, transdisciplinary, and heterogeneous. This inherently increasing dynamics of science faces us with the problem that the level of scientific literacy with which students are being equipped in schools is getting out of pace with the level of scientific knowledge that is produced and applied in other parts of society. Van Eijck, 2012, p. 1029

Van Eijck (2012) locates the construct of scientific literacy not in terms of economic competition, but rather the well being of communities in a world where the production and complexity of scientific knowledge is increasingly disparate from the forms circulated in science education. Given this situation, Van Eijck insists that we interrogate the very meaning of scientific literacy, and in particular, suggests that current work in the field of science studies has provided a new framework for thinking about the dynamics of scientific knowledge, which must also be taken up in our definitions of scientific literacy.

Van Eijck traces the attempt to document the dynamics of scientific practice to the work of Thomas Kuhn, after which "researchers became interested in what scientists actually *do* and how their actions shape scientific knowledge" (p.1030). Following this trend, scholars like Bruno Latour, Steve Woolgar, and Michel Callon began to produce ethnographies and historical case studies detailing the complex practices of scientists, which "undermined the possibility of any logical reconstruction of the processes that legitimise scientific theories that philosophers of science, such as the logical positivists and Karl Popper, were after" (Van Eijck, 1030). Van Eijck continues by examining the methodological implications of Actor Network Theory (ANT) on our understanding of science and society. Latour's (1991) *We Have Never Been Modern* is an early attempt at articulating the methodological framework of ANT, where he identifies a problematic schism in our modern constitution, those practices and objects of knowledge that constitute us as human. He suggests that our modern constitution contains two distinct parts: the top half, which has formed the basis of our explicit inquiry into the conditions of humans and their world, and the bottom half, which remains largely neglected. This

neglected portion is sometimes referred to as the proliferation of hybrids and networks, or the realm of quasi-objects. Unlike our methods of explicit inquiry, which have increasingly set out to purify the world into objects and subjects and other increasingly fine and polar categories of distinction, this bottom half involves those phenomena that are liminal and contingent and yet productive of staggering material consequences; the stuff of global climate change, tsunami warning systems, nuclear bombs, vaccinations— and I argue, science education—, which defy our every attempt to parse neatly into categories like science and politics, or nature and culture.

Latour is careful to distinguish his approach— of describing that which lies on the surface of our everyday habits and practices and simultaneously seems to elude our understanding— from the more usual trope of veils and mystification. Instead, his particular conception of our modern constitution comes from a different underlying mode of inquiry, endemic to both ANT and science studies more broadly: "Whatever label we use, we are always attempting to retie the Gordian knot by crisscrossing, as often as we have to, the divide that separates exact knowledge and the exercise of power – let us say nature and culture" (p.3).

Accordingly, "science cannot be appropriated by focusing only on the scientific concepts and the 'context' in which they are used, because this would again result in a reduction of scientific and technological artifacts to either natural, social, or discursive categories" (Van Eijck, p. 1031.) To prevent such reductive thinking, Van Eijck proposes an ANT-inspired model, showing the dynamics of science. In this model, science is understood as a set of five interrelated loops, constantly in circulation as scientific knowledge is produced, disseminated, and put to use. The loops are defined as follows:

1. Mobilization of the world: “the logistics of science, dealing with surveys, instruments and equipments, by which the world is converted into inferences” (p. 1031).

2. Autonomisation: “the institutionalizing of scientific enterprises (p. 1031).

3. Alliances: “institutions, such as the military, industry, and government, which are interested in physics, chemistry and political science, respectively” (p. 1032).

4. Public representations: “the process by which novel objects of science become massively socialized and part of the discourse of the public domain” (p. 1032).

5. Conceptual elements: “a series of links and knots that keep the other loops tightly together” (1032).

While this fifth loop does still exist in the center of the diagram, Van Eijck argues that this diagram reimagines science as a container, rather than a set of discrete content and conceptual ideas.

Van Eijck then provides a brief historical overview of different attempts to define scientific, and suggests that previous iterations have failed to appropriate the dynamics of science in two important ways. First, science literacy has often been defined in terms of the content that an individual needs to know. And even when such knowledge is viewed under a constructivist lens, this ignores the influence of diverse material and discursive factors, such as “alliances, instruments, colleagues, and other such elements that collectively make up the dynamics of science” (p. 1035). Second, the focus on content reduces science to the body of theories and ideas that are already known by scientists, which ignores the fallible nature of all scientific knowledge. Further, this fixes the practices of science within certain material discursive traditions, “which largely exhibit white middle-class and male epistemologies” (p. 1036).

In order to avoid these problematic positions, Van Eijck suggests that we should understand scientific literacy as "an emergent feature of collective human activity:"

> What ultimately counts as 'scientific literacy' can therefore only be understood by analysis of these systems, that is, be examining the manifold and interdependent means (speech, texts, tools, actions) by which knowledge is produced and hence distributed over and situated in collective human activity. 'Emergent', then, refers to the interdependent relationship in the evolving setting that, at certain points, exhibits specific characteristics such as scientific literacy. p. 1036

The ideal of collective action at the center of this reformulation challenges the individual nature of learning that is present in so many mainstream educational institutions and practices. Roth (2010) discusses the problematic prevalence of the mind-as-computer metaphor in science education research, which maintains the individual learner as the unit of analysis even as researchers emphasize the importance of socio-cultural and historical contexts. And while scholars may accentuate the situatedness of all learning, teachers are still required "to educate and test individual students. Even when students are allowed to learn in collaborative settings, the institutional requirements of evaluating learning at the individual level orients the endeavor of science educators to the individual" (Roth, 2010, p.7). Importantly, the practices of the Outdoor School where I conducted my research lack this requirement of individual evaluation. Students are not tested over their acquisition of knowledge, and instead engage in small group work where scientific literacy is indeed an emergent feature of collective group action.

At the same time, despite the repositioning of scientific knowledge as a container, rather than a set of facts to be contained, Van Eijck's model does not explicitly reject the unity thesis and the concurrent ontological commitment to mononaturalism. That is, Van Eicjk mobilizes the resources of science studies to critique the ways science education

has failed to adequately appropriate the epistemic complexity of the dynamic practices of science. This is only part of what science studies has to offer, and while it moves away from a framework that positions the social and epistemic aims of science education as inherently disparate pieces, it has yet to adopt the ontological politics that I argue offers a more robust democratic orientation for science education.

Science Studies and Ontological Politics

In his introduction to the *Science Studies Reader*, Mario Biagioli (1999) articulates the distinction between science studies—or science and technology studies (STS), as it is known in the United Kingdom— and other disciplines whose boundaries are set in relation to one another. In other words, for most academic disciplines, "the question of what defines a field emerges in the mundane context of sorting out and demarcating the pool of acceptable research material" (p.*xi*). Like the top half of our modern constitution, the traditional disciplines are intent on the work of purification and demarcation. Science studies, on the other hand, is defined by an object of inquiry; that is, "science— the set of scientists' practices, institutions, and so on—remains a socially delineated object no matter how you look at it" (Biagioli, p. 3). While such social delineations may be entirely contested and unstable, this framework allows objects of inquiry to remain in their flux and unruliness, and refuses to submit entirely to an externally normalized system of knowing.

John Law (2008) traces the origins of the field and its relationship to sociology more generally, noting how events like the Manhattan Project pushed intellectuals and the elite more broadly to better understand and control science and technology, as it

increasingly showed its influence as both a source of social improvement, and one of destruction. STS draws from both the Marxist tradition of sociology, and the broad question of how to distinguish between science and ideology, as well as traditions of micro-sociology, which paid closer attention to the practices of knowledge production as they unfold within particular contexts. Building on both of these traditions, the work of Thomas Kuhn left a lasting influence on STS in three distinct ways. First, as discussed previously, Kuhn understood science as a form of culture, rather than a representation of the world. Second, Kuhn paid attention to the detailed practices of science, which leads to a third major influence: a methodological insistence on case studies. These first two features are important to the critique of science education I offer here, and the third is a central component of my methodology, which I turn to in greater detail in the next chapter.

STS has grown and developed rapidly since the work of Thomas Kuhn, and Law (2008) identifies five major developments in the history of the field. First, the work of Bruno Latour and Steve Woolgar (1979) expanded the possibilities of case study analysis, from historical descriptions to ethnographic articulations of laboratories and scientific action in real time. Second, the focus on science expanded to include the realm of technology, which requires an understanding of science not simply as a discursive system or set of epistemic practices, but a form of material culture constantly in interaction with other systems like economics and politics. This leads to the third historical development: an emphasis on a relational logic that is evident in the description of ANT theory above. Fourth, if both material and discursive phenomena are relational, than reality cannot be foundational. Accordingly, Law locates STS within a space of

anti-foundationalism shared by French thinkers like Foucault and Deleuze. However, the fifth and final development, which Law locates within the thriving tradition of feminist scholars of science Donna Haraway and Sandra Harding, provides STS with a decidedly different political project:

> [S]ince knowing is also about *performing*, it is therefore about accepting the responsibilities that go with knowing. This, then, is a new kind of located and situated critical project, one that is profoundly political, but not foundational. Law, 2008, p. 634.

In other words, if reality is performed via the complex interplay of material and discursive practices, then it, too, can be done otherwise. It is not only our representations of reality that emerge differently, but the real itself. This, then, is a shift from concerns with epistemology, and towards the field of ontology.

In order to better explicate this move from a reality that is representation to one that is performative, I turn briefly to the work of Karen Barad. Karen Barad is a theoretical physicist who expresses unease at the frequency with which quantum physics is taken up in diverse scholarly domains. Her goal, she suggests, is not to use quantum physics as a springboard, or analogical tool, but rather "to examine specific implications by directly taking on a different set of epistemological and ontological commitments" (p. 70). In particular, Barad challenges the commitment to reflexivity that she suggests is so pervasive in contemporary critical practices. Barad argues that while reflexivity promises to complicate the process of knowledge construction by interrogating the role of the knower, it maintains a basic assumption that knowledge can authentically describe a preexisting world. In other words, reflexivity complicates the process of representing the world through knowledge, but does not challenge the underlying epistemological and

ontological assumptions. In particular, Barad suggests that such assumptions insist upon the existence of "individual objects with determinate properties that are independent of our experimental investigations of them," which "accounts for the fact that the process of measurement is transparent and external to the discourse of Newtonian science" (p. 106). Under this model, the reproducibility of experiments is used to buttress claims about an observation-independent reality, one that is simply passively awaiting our observations and descriptions.

Instead of reflexivity, Barad suggests that we construct a different methodology that builds from Donna Haraway's concept of diffraction. Diffraction refers to the process by which waves, both mechanical and electromagnetic, intra-act with one another to produce patterns that reveal not sameness but rather difference. Here, Barad's notion of "intra-action" insists that objects do not preexist their relationships, but rather come to be in relation to one another. When a light source is passed through a diffraction grating, or an obstacle with a single opening, the pattern of light that emerges on the other side is not the size or shape of that opening, but rather contains alternating bands of light and dark that are referred to as a diffraction or interference pattern. In other words, as opposed to "mirrors, which produce images—more or less faithful—of objects placed a distance from the mirror, diffraction gratings are instruments that mark differences in the relative characters (i.e. amplitude and phase) of individual waves as they combine" (p. 81).

The concept of diffraction undergirds the work of quantum physicist Niels Bohr. Bohr interpreted diffraction patterns as evidence that light can behave as both a particle and a wave, depending on the apparatus used in the experimental process of description.

Bohr's argument for the indeterminable nature of measurement and experimentation comes from his insight that "*concepts are defined by the circumstances required for their measurement*" (p. 109, emphasis in original). Consequently, there is no unambiguous way to differentiate between objects of measurement and agencies of observation. Significantly, Barad suggests that the work of Bohr denies the existence of an inherent Cartesian subject-object distinction, which further challenges the tenets of representationalism and the metaphysics of individualism. Accordingly, acts of inquiry are no longer aimed at preexisting objects of study, but rather complex phenomena that emerge as a result of specific practices of knowing. Barad understands Bohr's account of the world as proto-performative, and an important early shift away from the traditions of representationalist epistemologies.

Barad further complicates the work of Bohr by reading it diffractively through the writing of Judith Butler and Michel Foucault, articulating an expansive notion of performativity. While Barad disagrees with critics who understand the work of Foucault and Butler as purely discursive, she does acknowledge that "while Butler's account of materialization displaces matter as a fixed and permanently bounded entity, its temporality is analyzed only in terms of how *discourse* comes to matter" (p. 192). Similarly, Barad credits Foucault for fundamentally shifting the theorization of power and knowledge, but suggests that "there are crucial features of power-knowledge practices that Foucault does not articulate, including the precise nature of the relationship between discursive practices and material phenomena" (p. 200). On the one hand, Barad is seeking to extend the work of Foucault and Butler into a realm that is entirely posthumanist, where conceptions of performativity and the disciplinary apparatus can

extend beyond the borders of human bodies (see Barad, 2011). On the other, returning to Law's argument, Barad's reworking of performativity also extends the usually descriptive poststructuralist project into an account of the mutual entanglement of the material and discursive that is decidedly political, ethical, and ontological. That is, "We are responsible for the world within which we live, not because it is an arbitrary construction of our choosing, but because it is sedimented out of particular practices that we have a role in shaping" (p.203).

Law (2008) suggests that if Foucault is correct about the totalizing influence of the modern episteme, we become hard pressed to find resources for engaging in practices that enable new possibilities. However, if we heed Latour's claim that "we have never been modern," at least not in the complexities and pluralities of our practices, then we can grasp different practices as opportunities to engage different realities. I argue that the version of science education practiced at Multnomah Outdoor School offers precisely that—an opportunity to engage with realities of learning and teaching science that are performed differently. The question remains: different from what? On the one hand, differences are themselves relational, and this project does not seek to explain the practical differences between Outdoor School and the learning of science that the same students perform back in their home schools. On the other, I do think we can talk about a singular conception of nature, or mononaturalism, as a general feature of science education, as I have described in terms of both scholarship and policy. Consequently, offering a positive articulation of how science education can be practiced differently, producing realities that are multinatural, is precisely the aim of this project. To further

elaborate on the importance of this move to a science that is multinatural, I return to the philosophy of Bruno Latour.

The Politics of Nature

At its simplest, Latour's (2004a) *The Politics of Nature: How to Bring the Sciences into Democracy* is an attempt to revive the movement of political ecology. Latour acknowledges that attempts at political ecology are not new, but argues that previous efforts have failed to simultaneously interrogate the terms upon which such a movement rests, that is, both politics and nature. In other words, political ecology requires a reconstruction that will be slow, and Latour encourages us to act like moles, to burrow underneath the dichotomies that are so central to our metaphysical present. And to begin with, Latour has a seemingly strange suggestion: political ecology must cut its ties with " 'nature'—that blend of Greek politics, French Cartesianism, and American parks," adding that "the belief that political ecology is interested in nature is the childhood illness of the field, keeping it in a state of impotence by preventing it from ever understanding its own practice" (pp. 4-5).

In order to explain why political ecology has to let go of nature, Latour draws on insights from three diverse fields, combining insights from science studies, the practice of ecology movements, and comparative anthropology. First, from science studies, Latour suggests that we need to move from a conception of a singular Science, to an understanding of the sciences in the plural. That is, like Harding, Latour begins by refusing the unity thesis in science, defining "Science as *the politicization of the sciences through epistemology in order to render ordinary political life impotent through the*

threat of an incontestable nature" (p.10, emphasis in the original). The move from Science to the sciences requires that we abandon Plato's analogy of the cave, a pervasive metaphor that rends a gap between the social and the natural world, a gap that Scientists alone can cross. That is, this metaphor initiates a hierarchical arrangement of both different types of knowledge, and various classes of knowers. Within this hierarchy, scientists alone can speak for the objective natural world, an objectivity that forever trumps and short-circuits political debate by deciding in advance what knowledge is most important, most true, and least open to debate. Latour calls this a double interruption: "

> [T]he tyranny of the social world is miraculously interrupted when [the Scientist] leaves, so that he will be able to contemplate the objective world at last; and it will likewise be interrupted when he returns, so that like a latter-day Moses he will be able to substitute the legislation of scientific laws, which are not open to question, for the tyranny of ignorance. Without this double interruption there can be no Science, no epistemology, no paralyzed politics, no Western conception of public life. p. 11

Latour notes that this double interruption is not backed by anything empirical or rational. Indeed, it runs entirely counter to both experience and the practice of scientists. And, in order to maintain this strange metaphysics, Latour notes the important role of "the epistemology police" who paint all "who cast doubt on the double rupture as relativists, sophists, immoralists who want to ruin any chance we may have to accede to external reality and thus to reform society on the rebound;" thus, "the myth of the cave makes it possible to render all democracy impossible by neutralizing it" (p. 13). And while this metaphor substantiates a philosophical tradition that is decidedly epistemic, its consequences are simultaneously ontological and political—ontological in the sense that it maintains the belief in an objective and mute natural world in contrast to a subjective

though voluble social one, and political in that it determines in advance who has the power to make truth claims.

Second, from the practice of political ecology, Latour suggests that we learn why we must abandon the concept of nature: "*if 'nature' is what makes it possible to recapitulate the hierarchy of beings in a single ordered series, political ecology is always manifested, in practice, by the destruction of the idea of nature*" (p. 25). That is, if philosophy has progressed through a series of deaths—the death of God, the death of the subject—then the time has come to declare the death of nature. death; the death of God, the death of the subject, and now, the death of nature. And here, death is concerned with singular manifestations; what Latour is arguing for is the death of Nature as a singular entity. Against this problematic unification, the practice of political ecology "jointly forbids both the natural order and the social order to categorize in a definitive and separate way what counts and what does not" (p. 30). In other words, the unity of both nature and politics creates the problematic *a priori* separation of things into categories of facts and values.

Importantly, Latour is also quick to point out that he is not simply suggesting that we stop engaging with reality altogether, choosing instead to sit comfortably within a world where nature is only ever a social construct. In other words, treating nature as a social construct "only reinforces the division between the Cave and the Heaven of Ideas by superimposing this division onto the one that distinguishes the human sciences from the natural sciences" (p. 33). That is, while social constructivism seemed to offer the hope of a multicultural analysis, Latour suggests that "Multiculturalism acquires its rights to multiplicity only because it is solidly propped up by *mononaturalism*" (p. 33).

Refusing to engage with matters of reality altogether is tantamount to giving in to the myth of the cave, saving representations of nature for the privileged class of scientists alone.

Instead, we must offer articulations of plural natures. This at least temporarily blurs the distinction between nature and representations of nature, just not in the same way offered by social constructivists. This blurring is only the first step, and the second requires that we also redefine the social, moving from a definition of the social as subjective prison, and towards what Latour calls "the *social world as association* (p.37). By doing so, Latour shifts from the two-house collective, which he has previously referred to as the peculiar constitution of the Moderns, and towards a collective that no longer has recourse to a permanent and fixed exteriority, an exteriority that up to the point has been made up by this singular and incontestable nature. That is, if our secular modernity has at its core a transcendent nature, rather than a transcendent god, Latour's experimental metaphysics seeks to move beyond transcendent authority altogether. Accordingly, in Latour's newly defined social, "one can appeal to the external worlds, but the multiplicity that is being mobilized in this way *does not bring definitive resolution to any of the essential questions of the collective*" (p.39, emphasis in original).

Finally, Latour turns to comparative anthropology, though not because of the common myth that other cultures have richer conceptions of nature than do the "miserable whites who are guilty of wanting to master, mistreat, dominate, possess, reject, violate, and rape nature" (p. 42). That is, ecological movements have too often framed other cultures, especially those of indigenous communities, as noble savages. That is, Latour suggests that nature, as the singular ontological category we have come to

know in the West, is ours and ours alone. Instead, the tool of comparative anthropology "makes it possible *to extricate Westerners from exoticism they have imposed on themselves*—and, by projection, on others—by thrusting themselves into the impossible imbroglio of an entirely politicized nature" (p. 43).

Latour traces three problematic moves that troubled early iterations of comparative anthropology. First, the field began by positioning other cultures as primitive and closer to nature; then by imagining that other cultures live in harmony with the natural world, serving as defenders of nature; and third, by accusing non-Western cultures of complex correspondences between the natural and social world, continuing to insist on the presence of two incompatible worlds in the first place. In other words:

> Whites are neither close to nature because they alone finally know how it works, thanks to Science, nor distant from nature because they have lost the ancestral secret of intimate life with nature. The 'others' are neither close to nature because they have never separated it from their collectives nor distant from the nature of things because they have always mistakenly confused it with the requirements of their social order… [Instead], if we take nature away, we have no more 'others,' no more 'us.'" p. 46

In their place, we have various collectives of humans and non-humans, where democracy is *possible* now that nature no longer guarantees a singular and transcendent authority. I don't pretend that the unilateral authority of science is the only, or even primary, obstacle to democracy. At the same time, I do believe that the authority of science has been used as a tool of oppression throughout our modern history. As such, versions of science education that seek to actively intervene in oppression are responsible for addressing this authority. This is not a new claim, though Latour adds two additional facets to this story. First, he explains how this authority has proved so highly successful in staving off epistemic critique in the past: indeed, the historical emphasis on knowing and

epistemology in the West enables its own defense, generating debates about realism and constructivism, objectivism and relativism, while failing to address the ontological authoritarianism of a singular nature. Second, Latour offers an alternate path forward through the mobilization of ontological politics. As such, I ask: how can we begin to reconstruct versions of science education that adhere to the ontological politics of multinaturalsim?

Of course, there is no single answer to this question. Instead, it opens up space for a different conversation about the relationship between science education, justice, and democracy, and one that I hope can generate new questions and new possibilities for scholars and practitioners alike. As my location in the field of science education has shifted, from teaching students in the secondary setting towards the preparation of new cadres of science educators, I am also deeply invested in how the orienting principle of multinaturalism can support that work. Indeed, the two are not separate, and I believe that exposing students to a multinatural science education in their k-12 schooling experience affords different possibilities in terms of attracting a diverse group of individuals into the field of science education. And because the ODS program where my research takes place is actively involved in teaching science *and* developing new science educators, it provides an excellent opportunity to interrogate how multinaturalism may inform both of these aspects of science education.

In addition, I want to hold onto Van Eijck's (2012) reformulation of scientific literacy as an emergent feature of collective human activity, as this framing also helps secure the aims of scientific literacy in the context of democratic collectives, rather than

individual or societal advancement and competition. As such, I offer the following set of analytical questions to guide and inform the aims of this research project:

- How does this ODS program offer images of science pedagogy and curriculum that can inform a reconstruction of science education in which science literacy is conceived of as collective and multinatural?

This question is large in scope, and so I seek to break it down into several smaller bits:

- What types of curricular and pedagogical practices enact this definition of scientific literacy?
- How does this ODS program offer insights about what preparation and support science educators need in order to teach a scientific literacy that is collective and multinatural? That is, what types of practices encourage and enable future science educators to teach towards a conception of scientific literacy that is collective and multinatural?

In order to engage these questions, I follow a methodological approach that extends the tradition of case study and ethnographic work that has been a central feature of STS and science studies. First, I want to recognize that the theoretical framework I established in this chapter was not in place before I entered the field. This too is a feature of this methodological tradition, which refutes "a theory/data distinction…because in STS theory is not first created and then applied empirically. Theory and data are created together. However empirical it may be, everything is already theorized (Law, 2008, p. 629-30). While I began with a sense that the field of science studies had something to offer my attempts at articulating a positive aim for science education that moved away from the model of knowledge transmission and towards democratic action, I was unsure

of the precise form this articulation would take. Instead, I allowed my experiences in the field to become entangled with my attempts at theory building, a process I describe in greater detail in the following chapter.

Second, I suggest that this turn to experience is an important departure from earlier methodological iterations of science studies, such as early formulations of ANT. As Latour (2013) himself suggests, the ubiquitous metaphor of *networks* had a way of obscuring the different values and modes of being that inhabit the world. That is, they offered descriptions of knowledge production, without necessarily acknowledging relations of difference that enable for networks to proliferate and spread. As such, descriptions of networks often failed to resonate with the collectives for whom such networks mattered the most; they were flat and overly homogenous, ignoring the particular conditions of truth and objectivity that adhere to different modes of being in the world. In other words, the networks proposed by ANT were lousy at the work of diplomacy, at recognizing "how difficult it is to learn to *speak well to someone about something that really matters to that* person" (Latour, 2013, p. 46). Accordingly, in *An Inquiry into Modes of Existence*, Latour offers an additional methodological strategy: "I shall try to tease out an EXPERIENCE proper to each value… Because it seems to me that an experience, provided that it is pursued with care, can be *shared*" (p. 11).

In other words, the schism that Latour details, between the subjective world of the social, and the objective world of reality, is the same schism that has prevented Western traditions of epistemology from treating experiences with respect. Or, as Wildcat (Deloria & Wildcat, 2001) offers, "the most vexing issue confronting Western-influenced societies: the irreconcilable duality between facts and values," stems from "the failure of

Western metaphysics to produce an integrated big picture of human experience in the world as opposed to a big picture of the world" (p. 47).

CHAPTER III

METHODOLOGY

From the very inception of this inquiry project, the question of methodology has been a primary preoccupation. Part of this preoccupation came about because my interest in inquiring into the practices of this Outdoor School program felt so personal; my history as both a learner and teacher of science is deeply entangled with this program, and it felt all too easy to draw a priori conclusions about this educational phenomenon, conclusions that were based on experiences and memories not necessarily tied to rigorous research methods, or anything remotely resembling impartiality and objectivity, however problematic we might find those terms. So while I felt fairly convinced that something was happening at this Outdoor School program deserving of a sustained project of inquiry, I hungered for a methodology that would enable me to extend and draw from my previous interactions, while also giving rise to novel experiences that were not immediately sifted through a previously determined interpretive framework. That is, despite my familiarity with Outdoor School, and with the problems of science education as a broader set of practices and articulations, I wanted my methodology to provide room for surprise and disconcertment—I wanted my empirical explorations to challenge my expectations rather than provide a foundation for an argument made in advance.

In other words, I wanted to proceed with skepticism about my prior experiences, while also holding onto the belief that new experiences have the potential to rupture, to render problematic, that which we think we know; just as experiences can be limiting, they can also be productive of growth, of new possibilities and interpretations. Further, this cautious respect for experiences must inform not only how I treat my own

experiences, but also the experiences of my research participants. As such, I seek to articulate a methodology that respects experiences, while also understanding that all experiences are themselves partial transactions, involving necessary selections of this and not that, with/in worlds whose possibilities and potentialities are never themselves exhausted by any singular experience or description.

All of this rests on a particular reconstruction of experience that began with the work of John Dewey and William James, and has more recently been extended by thinkers like Charlene Haddock Siegfried, Vincent Colapietro, and Bruno Latour. And because I recognize the multiple and often conflicting ways that experience has been understood and critiqued throughout the history of both philosophy and the sciences, I begin with an effort to explicate the particular theoretical role that experience plays in the inquiry that follows. Importantly, this emphasis on experience is not a rejection of theory, nor does it suggest that in order to make space for new experiences, theory must be abandoned. Instead, it is to ask how a particular conception of experience provides a relational framework for rethinking how both theory and data are co-constituted and carried forward through our interactions with the worlds we attempt to know. Importantly, this theory of experience is also the center of my attempts to reconstruct a more equitable and democratic articulation of science education.

Dewey's Reconstruction of Experience

John Dewey's philosophic method begins and ends in the realm of experience. That is, experience, or the interaction between an organism and its environment, is both the source of meaningful problems towards which inquiry should be directed, as well as

the testing ground for determining the relative worth or value of a given object of knowledge. Accordingly, Dewey directs his empirical naturalism towards the conditions that give rise to objects of knowledge, and the consequences they engender in the realm of human affairs. Dewey's standard of inquiry may, he hopes, redirect the endeavor of philosophy back towards the issues that are most pressing to our historical present. And if this is the case, it seems certain that Dewey's empirical method has the potential to offer guidance to fields of inquiry that are inherently entangled with the practical affairs of people, such as the scholarship and practice of education. Dewey himself suggests that what are often deemed the applied sciences are much closer to his notion of inquiry than the typical paragon of pure science, as the connection between inquiry and lived experience is integral to questions of melioration and the betterment of present conditions.

As a scholar of education, and one deeply committed to the hope that scholarship can make a difference in the inevitable impact that education has on both present conditions and future possibilities, Dewey's emphasis on experience seems a crucial polestar, one that offers an orientation towards the problems of education that demand both deep and rigorous thinking, and a commitment to experimental action. Dewey is certainly no stranger to the field of education; indeed, he marks education as one of the four central concerns of his own philosophical project (1930, p. 19), and Siegfried (1996) describes the tremendous impact that Dewey's experience running the laboratory school at the University of Chicago had on his philosophical musings. Today, scholars of education in diverse subfields and theoretical dispositions often invoke Dewey's name. However, as Fendler (2003) notes, such invocations are often of an authoritative nature,

whereby the inclusion of a Dewey reference adds some credence to a scholar's larger project while the complexity of his broader philosophical method is largely ignored.

One difficulty in casually appropriating discrete Deweyan concepts for deployment in the scholarship of education stems from the fact that his philosophical project involves an attempt to redefine and reposition, rather than abandon, many of the central concepts that undergird the larger tradition of Enlightenment thinking. Accordingly, Dewey's writing is peppered with terms like experience, nature, intelligence, and reflection, all of which bear the weight of sedimented signification and customary use. Upon encountering Dewey's definition of experience outside the larger background of his works like *Experience and Nature*, it might be difficult to imagine how it offers anything other than a return to a philosophical tradition grounded on premises that our "postmodern" moment has proved untenable at best.

In the first chapter of *Experience and Nature,* Dewey recognizes that his theory of experience is radically different from other conceptions common in that time. He notes that describing his method as empirical naturalism runs against the grain of customary understandings of both terms. First, experience is often likened to "a veil or screen which shuts us off from nature" (1981, p.10). This is the premise of ideology in the tradition of critical theory. Second, to approach the complexities of human experience with the mechanical lens of nature amounts to denigration. That is, if we follow this later thread, Dewey's naturalism might seem to position him as an anti-humanist, and if we follow the former, his valuation of experience seems close to an enshrining that prevents the very possibility of critique. Further, given the influence of phenomenological approaches to qualitative inquiry, we may encounter references to experience as some pure and

undiluted Ur sense that is capable of revealing the ultimate essence of a fixed and natural world. Similarly, the notion of experience is often linked to a static and uncomplicated notion of identity or fixed subjectivity, and thus may seem to ignore the importance of difference and temporal flux in the construction of the self. In other words, it is clear that in order to grasp Dewey's concept of experience, it is also necessary to understand his nature and the subject.

Given the difficult interpretive situation outlined above, one might well wonder why anyone would care to go to the trouble to further describe a concept that seems so fraught. Indeed, later in his career Dewey expressed the desire to abandon the term experience all together, to be replaced by the term culture as it was being used in anthropology at the time. While I readily acknowledge the problematic and fraught nature of the term experience, it is difficult at the present to imagine that articulating a novel and exacting definition of culture is any easier task. Furthermore, if we heed Foucault's (1997) warning and refuse to give in to the "blackmail of Enlightenment," where we seek salvation in flight from and negation of, Dewey's empirical naturalism may be seen not as a recapitulation of past and problematic concepts, but rather a reconstruction that places such seemingly tired terms into new relationships. As such, I seek to explicate Dewey's reconstruction of nature and the experiencing subject in *Experience and Nature,* in hopes of providing a space for renewed discussions of Dewey's theory of experience as a resource for various practices of education. The intent is not to produce a final and authoritative interpretation of Dewey, or to convince his detractors of his merits, but rather to renew an engagement with a thinker who saw education as a deeply important component of our ongoing democratic experiment.

Darwin and the nature of nature

> The conception of *eidos*, species, a fixed form and final cause, was the central principle of knowledge as well as of nature. Upon it rested the logic of [traditional] science… Completely to know is to relate all special forms to their one single end and good; pure contemplative intelligence. Since, however, the scene of nature which directly confronts us is in change, nature as directly and practically experienced does not satisfy the conditions of knowledge. Human experience is in flux, and hence the instrumentalities of sense-perception and inference based upon observation are condemned in advance. Dewey, 1973, p. 34

In *Experience and Nature*, Dewey examines the conditions of our historical preference for the all that is stable, universal, and consummatory, and the consequences this preference produces regarding our understanding of experience, nature, and inquiry more broadly. Dewey traces this system of valuation to the Ancient Greeks and the division of society into classes of labor and leisure, where leisure involved contemplation of the ultimate forms of Truth and Good, while labor aimed at transforming things in their contingent potentiality towards their stable Being. Such conditions converted "the stably good object into a definition and description of true reality in contrast with lower and specious existence, which, being precarious and incomplete, alone involves us in the necessity of choice and active struggle" (Dewey, 1981, p.51). At best, the transitory objects of the natural world could undergo transformation towards their essential ends. Consequently, the ultimate objects of inquiry were the formal products of the fine arts, where such art was thought to reflect the true forms of the ideal, the universal, and the True.

For Dewey, the advent and import of modern science emerged when inquiry as a practice began to engage differently with the ontological status of nature. This ontological shift was afforded by taking experience as it is: "If we trust to the evidence of experienced things, these traits [of precariousness and stability], and the modes and

tempos of their interaction with each other, are fundamental features of natural existence" (1981, p.67). That is, attending to the peculiar combination of both the stable and the precarious aspects of the natural world gave rise to an attitude of experimentalism, where "[t]o be intelligently experimentalist is but to be conscious of this intersection of natural conditions so as to profit by it instead of being at its mercy" (p. 63). Dewey identifies the seeds of this view of nature in scientific thought as early as Galileo, Copernicus, and Kepler, and highlights the work of Charles Darwin brought as the force that brought this ontology to bear on the realm of the living. Accordingly, the "[t]he influence of Darwin upon philosophy resides in his having conquered the phenomena of life for the principle of transition, and thereby freed the new logic for application to mind and morals and life" (Dewey, 1973, p.35). Through the work of Darwin, the concept of species is thrown into relational and temporal flux; nature is no longer naturing towards some fixed and final goal, and humans too must be conceived of as in and of the complex processes of our interactive world.

Because experience emerges from our engagement and transaction with the natural environment, all of the qualities of human experience—joy and tragedy, excitement and ennui, permanence and precariousness, truth and uncertainty—are themselves of the world as well. In other words, when our interaction with the world "presents esthetic and moral traits, then these traits may also be supposed to reach down into nature, and to testify to something that belongs to nature as truly as does the mechanical structure attributed to it in physical science" (Dewey, 1981, p. 13). The point is not that experience reveals some universal truth about the world, as Dewey (1984) insists that all experience is situated, occurring within distinct and singular situations that

are distinguished by a unifying quality. Such qualities are themselves ineffable; they provide the beginning points of experience, and because experience is interaction with the world, the very act of experiencing involves choice, or selective emphasis, and thus movement towards something other than the initial qualitative situation. Knowledge is the result of the selective emphasis and choice that occurs in all processes of inquiry. Knowledge can result in intelligent action, providing us with leverage, the ability to manipulate world in order to bring about certain results. The mistake that haunts our metaphysics, our theory of nature, our ontology, however, is belief that this selective act of knowing produces objects that are more real than those of experience.

The differences between objects of scientific knowledge and the world of experience are the inevitable results of inquiry. Historically, however, such differences have been used to mark distinctions between the phenomenal and the noumenal, appearance and reality, practice and theory; that is, such differences have been placed in hierarchical relationships where the permanent and true is erected above the precarious and uncertain. At the same time, we project the mathematical aspects of the systems of science we praise the most onto the world itself; the world becomes a mechanistic and inert realm of predictability and universal laws. Against this ontological system, the work of Charles Darwin stands as an "acknowledgement of nature as a scene of incessant beginnings and endings… [and] enables thought to apprehend causal mechanisms and temporal finalities as phases of the same natural processes" (1981, p.83). Consequently, inquiry forgoes a commitment to ends that are final representatives of Being, focusing instead on ends-in-view, possible momentary termini in natural sequences of events towards which knowing can be directed. By emphasizing the relationship between

human experience and the environment, Dewey reconfigures the natural world as a site of incessant drama, marked by energies and processes that both frustrate and satisfy our striving towards particular ends-in-view. The claim that humans are of and in nature is not a denigration of humanity, but rather an expansive valuation of nature.

This shift from final ends to ends-in-view had a number of important consequences: "A thing is more significantly what it makes possible than what it immediately is" and thus, "the character of intellectual meaning is instrumental" (Dewey, 1981, p. 105). The instrumental capacity of objects of nature is apparent in the practice of scientists and artists alike. The problem, then, exists in our inability to give up on the Greek ideal that knowledge, or the object of inquiry, represent some final and ultimate nature of reality. In other words, "[t]he notion of knowledge as immediate possession of Being was retained when knowing as an actual affair radically altered" (p.109). We return to the erection of objects of knowledge, and of the mathematical knowledge of science in particular, as the ultimate Real, and the denigration of quotidian experience. This also sets theory and practice as odds with one another: "Although science is concerned in practice with the contingent and its method is that of making hypotheses which are then tried out in actual experimental change of physical conditions, its traditional formulation persists in terms of necessary and fixed objects" (p. 124).

Practices of Freedom and a Decentered Subject

> Decentering the subject is the negative side in affirming the centrality of practices. Affirming this centrality does not entail annihilating subjectivity, though it does involve situating subjectivity and thereby problematizing what is to be understood by the term. Colapietro, 2011b, p. 24

The difficult relationship between theory and practice is greatly evident in the scholarship of education, and in *The Sources of a Science of Education,* Dewey is presciently aware of this tension. He proposes that scientific theory does indeed have a role to play in the shaping of educational practices, but is fearful of the "tendency to convert the results of statistical inquiries and laboratory experiments into directions and rules for the conduct of school administration and instruction" (1929, p.18). That is, the philosopher's fallacy, of mistaking products of inquiry for antecedent conditions, is also the fallacy of education and its scholarship, ignoring the importance of experience as both the source of theory, as well as the realm where theories must be put to the test. As such "laws and facts, even when they are arrived at in genuinely scientific shape, do not yield *rules of practice*. Their value for educational practice… consists in provision of *intellectual instrumentalities* to be used by the educator" (Dewey, 1929, p. 28).

In "Customary Reflection and Innovative Habits," Vincent Colapietro (2011a) seeks to reverse the traditional belief that habits possess the trappings of stasis, while reflective thinking alone contains the seeds of novelty. That is, rather than seeking to change practice through the production of innovative knowledge or new forms of epistemology, practice itself becomes both the source and testing ground for transformative change. So while "participation in these [customary] practices always serves, in some manner, the prolongation of them…it is, almost without exception, only by means of participating in practices that alteration of them is possible" (p.168). This ordering refuses the belief that systems of practice themselves are inherent structural constraints, which can only be improved by outside sources of knowledge. Like Foucault, Dewey (1981) insists that "there is no exclusively one-way exercise of

conditioning power, no mode of regulation that operates wholly from above to below or from within outwards or from without inwards" (p. 65). Power is immanent in practice, and so is resistance: "the promise of possibilities inscribed in the writings of Dewy and Foucault are thus sounded anew, for the sake of facilitating our own engagement in practices of freedom" (Colapietro, 2011b, p.23)

Colapietro (2011b) suggests that "the practice of freedom, as conceived by Dewey and Foucault, requires us to understand the *situated* character of human striving" (p. 24). That is, Colapietro points to the emphasis both authors place on the historical situation within which various modes of subjectivity emerge. Far from positing a stable and unified subject position, Dewey's experiencing subject is first and foremost an experimental one; rather than seeking radical emancipation from the contingent constraints of particular situations, the subject implicated in practices of freedom aims at "rendering thought increasingly susceptible to the transformative power of our actual encounters, thus of enveloping circumstances (or situations)… in an through which one's improvisational efforts alone can generate differential effects" (Colapietro, 2011b, p. 26). Importantly, Dewey's decentering of the subject is not simply a negation of previous articulations, but rather a positive reconstruction that seeks to contest the belief that "experience centers in, or gather about, or proceeds from a center or subject which is outside the course of natural existence, and set over against it" (Dewey, 1973b, p.74). Like Foucault's theory of power, Dewey's experience is no longer a thing done, but a doing. Understood as a transaction between an organism and their environment, experience is both a constraint and point of contestation. Just as our experiences can form sedimented habits, naturalizing precarious choices and acts of agency that could

have been otherwise, it is also within the realm of experience that contradictions, disconcertment, and novelty arise. Further, experience is neither fully determined nor shaped by individual agency and choice alone, nor is it simply a causal response to external influences. Both Dewey and Foucault reject the logic of either/or that has encouraged us to emphasize structure or agency, radical individualism or social determinism, and instead provides a new space for imagining both experience and power as immanent and relational.

Dewey's Situated Subject

In *Experience and Nature*, Dewey begins the chapter titled "Nature, Mind, and the Subject" with the following assertion: "Personality, selfhood, subjectivity are eventual functions that emerge with complexly organized interactions, organic and social" (1981, p. 162). Accordingly, he seeks to describe the conditions and interactions that gave rise to various historical modes of subjectivity, and their attending consequences. In the tradition of Ancient Greek thought, the equation of Being with perfection and consummation led to the subordination of individual variation to the immutable category of species. That is, "what moderns call individuals were particulars, transient, partial, and imperfect specimens of the true individual" (p. 162). While this view seems strange when viewed through the lens of modern science, Dewey traces this belief to a particular cultural scheme. In other words, Dewey argues that this conception of subjectivity emerged from a particular mode of experience that found generic traits to be more lasting and permanent than individual instantiations. As such, "the modern habit

of using self, 'I,' mind, and spirit interchangeably is inconceivable when family and commune are solid realities" (163).

Within this context, "[p]rivate belief and invention were a deviation, a dangerous eccentricity, signs of disloyal disposition. The private was an equivalent of the illicit; and all innovations and departures from custom are illicit" (p. 164). And yet, in spite of custom and tradition, innovation and reconstruction always occur on some level, for "utensils, traps, tools, weapons, stories, prove that some one exercised at sometime initiative in deviating from customary models and standards" (p. 164). Dewey's point is simply that within certain social contexts, the positive aspects of innovation and creativity were masked; when "[t]he group is small enough to be homogenous; innovations are conspicuous and focus resentment; …Under such circumstances, individual variation of thought remain private reveries or are soon translated into objective established institutions through gradual accumulation and imperceptible variations" (p.165).

Importantly, Dewey argues that this previous conception of subjecthood and individuality is not a product of "hypostatizing psychical states and process" but a metaphysics that "converted not psychological conditions but positive institutional affairs into cosmic reality" (p. 167). That is, it emerged from a particular mode of experience in the world, an experience derived from concrete qualitative situations. The shift towards our modern exaltation of the subject— as source of all creativity and innovation— was born from a different set of conditions. On the one hand, different modes of experience emerged when the social milieu transitioned from small homogenous populations to diverse and rapidly changing communities. Within this context, "the tradition of order

and unity is still vital while the actual state of affairs is one of variation and conflict, and there is a situation in which dependence must perforce be placed on individuality" (p. 167). However, this context is also one marked by a metaphysics that mistakes such emergent eventualities for antecedent conditions. That is, the same metaphysical tradition that separated the human subject from nature, that viewed both the natural world and positive human institutions as sources of antiquated customs, sought to understand this newly experienced creative subjectivity as something either wholly independent or entirely transcendent:

> If the given science of nature and given positive institutions expressed arbitrary prejudice, unintelligent custom and chance episodes, where could or should mind be found except in the independent and self-initiated activities of individuals? Wholesale revolt against tradition led to the illusion of equally wholesale isolation of mind as something wholly individual. Dewey, 1981, pp. 173-174

Accordingly, our modern understanding of subjectivity is one where creativity and agency are causally produced by minds that have somehow gained independence from the bodily trappings of habit and custom. While such minds are the source of innovation, they are also wholly internal and possessive, the source of private fancy and inner retreat from the confines of the material world. And because the objects of knowledge produced by the physical sciences continued to reinforce a conception of the natural world as wholly objective and separate from the processes of creativity and imagination, these seemingly separate modes of inquiry result in the erection of a strict subject/ object divide. Experience, too, becomes imbued with the possessive quality attributed to subjectivity, rendering it unable to reveal the "objective" truth about either the self or the external world.

In response to this predicament, Dewey (1981) offers the following: "An adherent of empirical denotative method can hardly accept either the view which regards subjective mind as an aberration or that which makes it an independent creative source. Empirically, it is an agency of novel reconstruction of a pre-existing order" (p. 168). As humans, we find ourselves immersed in qualitative situations, and the selections and inquiries we engage in are always conditioned by habit and custom. Subjectivity, then, plays not an absolute causal role in acts of novel creation, but rather an intermediate and relational one. "It involves a dissolution of old objects and a forming of new ones in a medium which, since it is beyond the old object and not yet in a new one, can properly be termed subjective" (p. 171). Dewey repeatedly emphasizes that dualisms like subject and object are not inherently wrong; they represent objects of knowledge that emerge from particular historical conditions, and produce certain consequences. What Dewey is concerned with, then, are the consequences of holding onto these objects of knowledge as permanent and universal, rather than attending to the particular situations from which they emerge. In this case, "the dualism erected between the ego and the world of things and persons represents failure to attain solution of the problem set by this ambiguous nature of the self" (p. 188). Here, Dewey is clearly denying any sort of normative appeal to a static and fixed essence of human nature. Instead, the self is an emergent process, and the crucial intermediary step between the current state of affairs, and the possibility of making them otherwise: "The old self is put off and the new self is only forming, and the form it finally takes will depend upon the unforeseeable result of an adventure. No one discovers a new world without forsaking an old one" (p. 189).

Situating Dewey's philosophical project within this larger ontological framework troubles the notion that "American pragmatism has inherited … an outlook that is both profoundly anti-intellectual and politically disempowering" (Stetsenko, 2010, p.78). At its very core, Dewey's philosophy contests the subordination of human experience, in all its various and conflicting forms, to any external law or universal norm. His critique of modern metaphysics is simultaneously a critique of the naturalization of hierarchical orderings, and by insisting that the world is as it is experienced, Dewey provides a framework for acknowledging the material effects of oppression without reifying the existence of antecedent categories of difference. At the same time, Dewey's understanding of experience as reconstructive, and the self as adventurously in flux, provides the grounds for thinking projects of positive inquiry beyond the foundationalist epistemological and ontological commitments of positivism.

Building from Dewey's theory of experience, I now turn more directly to the question of how to engage my own experiences, and those of my research participants, ensuring that both are able to disrupt, produce disconcertment, and fuel a methodology that is experimental. Here, I use the term experimental to signal an approach where theory itself is put to the test, in order to find the limits of its usefulness. In the gaps and holes exposed by such experimentation, I hope to provide space for new theories to enter into the project of inquiry, theories that undergird different acts of selection, and call different questions to the fore. Imbuing experience with such a critical task requires that I confront two problematic habits: the first, the tendency to cede the weight of experiences to external authorities; and the second, the ease with which we negate our

own experiences when they fail to conform with the expectations of taken for granted interpretive frameworks and understandings of the worlds around us.

Refusing these habits is difficult, and such a refusal can feel arrogant, and dismissive of theory altogether. Here, I want to emphasize that refusing to cede and negate our experiences is not a turn away from theory; our interactions and efforts at inquiry are always tangled with theory and value systems. The point, then, is not to rid ourselves of external systems of thought, but rather to become more acutely concerned with how and when they intervene in the treatment of experiences, both our own and those of others. This, I argue, Accordingly, I turn to the work of Vincent Colapietro and Helen Verran to imagine how experiences comes to be ceded and negated, and what it might mean to refuse these habits while engaging with the experiences that emerge in and during projects of inquiry.

"Experience Ceded and Negated"

> [Experience] must now be renewed in the name of experience more vibrantly lived, and, quite simply, more fully had… [This] practically means refusing to cede our experience and its interpretations to any authority, including the most invisible form (that of our own habitual selves in their ingenious capacity to make sense out of our experiences primarily in terms of entrenched dispositions of interpretation and evaluation). Such a refusal entails opening ourselves to the transformations, transfigurations, disruptions, and thus upheavals of our transactions, as they are actually taking place in the present. Colapiero, 2008, p.118

This refusal emerges from a distinction that Dewey makes between having and knowing. When experience is conceived of as an affair that is primarily cognitive in nature, the affective, ethical, and political aspects of the world become suborned, and the nature of nature itself falls back on the mechanistic descriptions afforded by certain

modes of inquiry. Against this reduction Dewey (1984) suggests that when our experience yields "esthetic and moral traits, then these traits may also be supposed to reach down into nature, and to testify to something that belongs to nature as truly as does the mechanical structure attributed to it in physical science" (p. 13). Colapietro denotes two ways that experience is lost before it can be had. First, when experience is positioned as inherently spurious in relation to transcendent truths, we become all too willing to cede our own experiences to external authorities. Second, we negate our experiences by insisting that they be rendered meaningful via our existing interpretive frameworks. In other words, while experience is an instance of semiosis, the belief that "the human mind *imposes* meaning on otherwise meaningless data…offers a grossly mistaken account of human experience" (p. 120).

Dewey's distinction between "having" and "knowing" foregrounds experience as an "encounter with the other in which the identities of all parties implicated in the transaction are put at risk" (Colapietro, p. 118). Experience, then, becomes a mechanism by which the diverse constituents of the world, including both human and non-human agents, come to matter, and to push back on certain entrenched habits and interpretive assumptions. In other words, experience itself becomes a tool for moving beyond our entrenched interpretive frameworks, human-centered or otherwise, directing our attention back towards the everyday world as:

> [A] site in which the possibilities of novel, improvisational interpretation are realized in the teeth of entrenched, sanctified pre-interpretation. The implosion of the interpretive frameworks so relentlessly, so effectively protecting the done thing, the conventional patterns, is often at the center of our experience. Colapietro, 2008, p. 124.

A Relevant Example

To provide an example of what this might look like in practice, I move to the work of Helen Verran (2001), whose book *Science and an African Logic* can be seen as an implicit example of how the pragmatist reconstruction of experience can provide leverage for imagining new approaches towards inquiry in qualitative studies of education. Verran describes her experiences working as a university instructor in Nigeria, where she supported local teacher's implementation of curriculum materials produced as "part of a large and prestigious Western aid program that sponsored curriculum development in science and math …in the 1960s and 1970s" (p.1). In the opening chapter, she focuses on a pervasive feeling of disconcertment that accompanied her work observing and evaluating these local educator's efforts to teach their students various techniques for measuring things like height and lung volume. In the teachers' practices, the measurement techniques were sometimes modified slightly, and importantly, the students of those who modified their lessons often demonstrated greater success at the measurement task than those who followed the prescribed curriculum exactly.

In one example, she describes a teacher's enactment of a lesson where students used pieces of string and metric rulers to measure the length of various body parts. Prior to the lesson's performance, Verran worked with the local teachers to develop a lecture on the concept of length, and an associated activity involving hands-on practice, where pieces of string were used to measure something like height, or arm length, and then placed on the floor where it's length was marked with chalk. Then, when one of the limited metric rulers was available, this length could be measured in standard metric units, and recorded. As the lesson unfolded in one classroom, the instructor did not begin

with the lecture, and modified the collection technique with the addition of a seemingly innocuous step: instead of transferring the string onto the floor to mark the length as a unitary extension, the teacher wrapped it around a cardboard rectangle that was exactly 10 cm, transforming the length into a plurality. Through multiplication, this plurality was eventually converted to a unitary length that was consistent with the prescribed measuring technique. Verran's disconcertment arose due to her feeling that, on the one hand, the choice of measuring technique did not matter; both arrived at an expression of length as unitary metric quality. On the other, when Verran observed other instructors deploy the lesson exactly as it had been previously practiced under her guidance, students were less likely to generate any data at all. Importantly, Verran sees this disconcertment not as a problem in need of solution, but rather a guide to her attempt at theorizing the situation at hand:

> [T]his disconcertment, source of both clear delight and confused misery, must be privileged and nurtured, valued and expanded upon. These fleeting experiences, ephemeral and embodied, are a sure guide in struggling through colonizing pasts, and in generating possibilities for new futures. As a storyteller (a theorist) I treasure these moments, I do not want to explain them away. It is easy to ignore and pass by these moments—part of the problem is their fleeting subtlety—yet it is possible to become acutely sensitized to them. Interruptions, small and large are what we, as theorists, must learn to value and use. Verran, p. 5

It took Verran approximately fifteen years to write her book. Along the way, she wrote various manuscripts and articles about her experience, but felt that each attempt to write resulted in an inevitable "explaining away" of the disconcertment following her observations and what she came to refer to as "differing accounts of the generalizing logic of numbers" (p. 14). Verran felt like she had only two options for analyzing her observations: a universalist framework that understood numbers as natural abstractions

that could be found as inherent structures in either nature or mind, or a relativistic framework that understood numbers as the products of diverse human cultures. While Verran felt certain in her rejection of the universalist framework and its colonizing implications, she was surprised that the relativistic framework she did adopt left her feeling equally unsatisfied.

Verran's dissatisfaction has two sources. First, she shows that a relativistic framework continues to treat numbers as found objects. That is, while the relativistic framework may tell a different story about the origin of numbers than the universalist approach, both treat numbers as stable objects that researchers can find and appropriate as objects of inquiry, which "fails to recognize the creativity of collective life as a logical going-on in actual times and places" (p. 29). Second, Verran's dissatisfaction comes to a climax when she begins to wonder how the results of her relativist analysis might inform the policy of education in Nigeria, which "carries the absurd implication that bilingual Yoruba knowers of logic and mathematics must in every circumstance choose consciously and deliberately to be one thing or the other, with 'us' or with 'them'" (p. 28). In the end, Verran includes her three original relativist manuscripts in the final text, and follows each with two additional chapters that decompose and reconstruct her argument using an emergent framework that seeks to "explain what numbers are in terms of here-and-now routines of practice, ongoing collective acting" (p. 94).

I suggest that Verran's work exemplifies John Law's (2008) claim about the relationship between theory and data in theoretically informed case studies: "Theory and data are created together. However empirical [a study] may be, it is always already theorised. And empirical case studies… are important because they articulate and rework

theory" (p. 630). At the same time, Verran's work demonstrates the difficulty of navigating a research project where theory and data emerge together. Importantly, I don't want to avoid this difficulty; instead, I argue that Verran's work demonstrates the importance of treating experience as an object of inquiry when methodological difficulties emerge. That is, experiences provided the ground from which a novel and disconcerting problem emerged, and prompted an examination of the consequences that Verran's theorizing might have enacted in the world. Rather than trapping her in a positivistic form of interpretivism, Verran's refusal to cede or negate her experience resulted in the achievement of a novel analytical framework that displaced traditional human-centered and foundationist analysis. Accordingly, I argue that the pragmatist reconstruction of experience provides a mechanism for questioning and sometimes abandoning our well-worn interpretive frameworks, as well as reconstructing new ones.

The Fall Pilot Study and Participant Observations

In order to honor my desire to allow the objects of inquiry in this project to emerge on their own accord, without sorting them through a priori categorizations and hierarchies of importance, I conducted a pilot study. There was also a practical issue here, of not knowing precisely what it was that I wanted to collect in terms of data, or even what would constitute my data, and of all of these unknowns disabling my attempts to pass through the hoops of the IRB process. In other words, my desire to be in the field without a rigid methodology was itself seen as a problem within the institutional setting of social science research, and research with human subjects more specifically. Importantly, it was precisely an ethical consideration that kept me from making decisions about method before hand; this move of framing a research project without first inquiring

into the things that matter to those involved, to those beings who I hoped to incorporate into my study in the first place. So if a rigidly defined method is itself an affront to the relational ethics I hoped to establish as a researcher, I began to envision the pilot study as a means of refusing method, even if only temporarily.

My pilot study was an effort to have an experience before attempting to know it, recognizing again that knowing is but one aspect of our experiences with the world. As such, the emphasis on epistemology, and knowledge production, that is inevitably the center of academic investigations, can also serve to narrow our interactions with research participants and settings. The very act of knowing seems to place the beings who populate our research into strict classes like subject and object. And because this epistemological distinction is undergirded by a particular set of metaphysics, these beings also become differently valued, and carry different ontological weights. My efforts at having and experience, then, were attempts to recognize the aesthetic, the emotional, and the political, dimensions that have been particularly threatened by the regime of objectivity that circulates through much of science education research.

My primary objective was to document the practices of ODS, with a particular focus on the curriculum that was being enacted during the field studies, and the broader educational ethos that ran through the program. And, I carried with me some loose theoretical orientations that I believed would provide useful tools for making sense of what I would observe. First, I wanted to explore the workings of this Outdoor Residential Science program as a site of inquiry for moving towards a more specific definition of scientific literacy, and one that might be more useful to the practice and policies of science educators hoping to push against white supremacy and other anti-

democratic tendencies that cling to our tradition of science in the west. Second, I wanted to push back on some problematic assumptions in science education that are reified by an assumption that agency is a feature of human action alone.

Context and Duration

My pilot study was approximately eight weeks in length, during which I lived at one of the three Outdoor School sites that was operating during the fall session of 2015. I chose this site because the site supervisor had been my site supervisor when I worked from the program ten years earlier, and we have remained friends since. I spent time with staff before the sessions with sixth graders began, observing during a training the field instructors received about STEM, spending several nights with them during their prep week, and observing during the workshop they hold for student leader volunteers.

The instructional portion of the program was scheduled across seven weeks. As I discuss earlier, Outdoor School traditional ran weeklong programs, but because of recent budget cuts, many schools could only afford to send their students on half-week programs. In the full week program, students arrive on Sunday afternoon, and remain on site until Friday around 1:30 PM. During weeks where two half sessions run consecutively, the first group of four classes arrives Sunday afternoon, and departs on Tuesday evening. The second group of four classes shows up the following Wednesday morning, and departs Friday afternoon. Regardless of the program structure for the sixth grade students, the high school student leaders always volunteered for a full week. During the first week, a traditional full week program took place. During weeks two

through six, each week saw two half-week programs. Week seven was scheduled for a single half week, and ended up being cancelled because of inclement weather.

In the fall, I acted as a participant observer, and lived full time on site from noon on Sunday until Friday at five for each of the six weeks the site operated. During those six weeks, I experimented with multiple ways of being and interacting with both the staff and the learners involved. For example, Emerson (1995) describes various approaches to both "ethnographic participation," and ethnographic observation, suggesting that:

> [I]f substance ("data", findings', "facts") are products of the methods used, substance cannot be considered independently of method; what the ethnographer finds out is inherently connected with how she finds it out. As a result, these methods should not be ignored. Rather, they should comprise an important part of the written field notes. It thus becomes critical for the ethnographer to document her own activities, circumstances, and emotional responses as these factors shape the process of observing and recording, others' lives. p. 6

I began by thinking about the multiple ways that I could move through the program, and how these different approaches might themselves change the scope and tenor of what I sought to understand. That is, because different staff members work in such particular niches within the larger program, and because the 6th grade students themselves move through the program in particular ways, I wanted to move through the program myself in ways that exposed me to the multiple parts of the program, as well as to the program as a whole. Further, because classes of students move through the program together, different methods of moving could either focus on moving with 6th graders, where I would then only get to know a portion of the students participating during that time setting, but might see better how the program impacts student learners over the course of one session.

That first week I also tried several different approaches to documenting the learning during the field study portion of the program, which involved varying my participation and my closeness to the actors and agents involved. At times, I made efforts to fade into the background, and to document the curricular approaches and general features of the learning environments to the best of my ability. However, because the majority of the learning occurs in small groups, and because I had to be physically proximate in order to hear what was going on, I was never really in the background. Further, because I was introduced as a staff member, my interactions with student leaders and sixth grade students were shaped in advance by the their expectations about the roles of staff members during field study time more broadly. Staff members do circulate during field study, and are typically either available to join in and support groups, or are carrying small notepads in efforts to write down observations that inform the evaluations they offer to student leaders at the end of each week. As such, being an observer always felt more evaluative than being a more direct participant. Moreover, the trope of the passive, distant observer felt tied to an emphasis on knowledge that I was working hard to complicate, and I became more comfortable engaging with the student leaders and sixth grade learners more directly, and writing up my observations each evening.

During any given week, each field study typically has between four and seven high school student leaders, which then determines the possible number of small groups each field study can run. And sometimes in the beginning of each week, student leaders are paired up, or assisted by staff members, to ensure that they are comfortable with the teaching expected. So another complication involved deciding which group of students I would choose to interact with and observe. Often, I asked the field instructor to point out

a student leader whom they felt would be comfortable with my presence. I suppose this means that I observed mostly returning student leaders, and there certainly were a wide variety of different degrees of comfort that accompanied my early interactions.

At times, student leaders explicitly invited me to enter into the teaching and learning, and at other times, I ended up playing a more passive role. There were also several occasions, although they weren't that common, where I stepped in on my own accord, either to help with classroom management, or to pick up on content questions that extended beyond the knowledge of the student leader. For example, I recall being on a hike with a group of students and their student leader during a hike on animals field study, and while talking about camouflage, the students began asking questions about the nature of light and vision more broadly. I entered the discussion, talking about how differences in pigments' ability to reflect and absorb different portions of the visible light spectrum gave rise to the colors we see. This intrusion clearly shaped the rest of the dynamics during this field study, and students began to direct questions towards me, instead of their student leader. This was never my intent, and after this experience I became more cautious with my interventions.

As I made my way through the first couple of weeks, more than discovering that any singular way of moving though the program was better than the others, I recognized that each brought about different sorts of insights. Following classes of students as they rotated through the different field studies aided my ability to understand how the educational practices of Outdoor School also involved certain patterns and habits of action, and that depending on the context of the school the students attended, and the educational philosophy of their teachers, the learning and teaching at Outdoor School felt

variably comfortable or foreign. On the other hand, when I remained with a single field study for a single span of the program, I noticed the differences that emerged as students were able to think differently about the same field study depending on which field studies they had encountered earlier in the week. It also enabled me to develop closer relationships with the student leaders teaching on that particular field study, so that my attempts to observe and interact with the learning that unfolded felt less awkward than when I dropped in to observe student leaders I had not yet come to know.

The program is interesting in terms of its compartmentalization: staff members are typically involved in the teaching of only one of the field studies, and share other jobs so that there are not always many opportunities for staff members to witness the work of each other, or to understand how the lessons being taught in one field study interact with the others. Realizing what a tremendous gift it was for me to be able to move freely through the program as a researcher, I spent the last two weeks of my fall observations returning this gift in kind to the four staff members directly in charge of the field study portion of the learning, taking over each of their jobs for a half week session, allowing that individual to be the researcher for the week. Our debriefs after their experience became an integral part of my field notes. This process also reminded me of just how situated our knowledge is (Haraway), and how important it would be for me to conduct interviews with a wide swath of the program's participants in order to begin to understand precisely how the program works. And, this is not to suggest that I could ever collect enough data so as to be able to pinpoint or triangulate some true, or even most accurate, description of the program. Rather, it is to acknowledge the diverse workings

of Outdoor School, and the multiple and sometimes conflicting ways individuals experience and narrate those workings.

Further, I want to recognize that despite my attempts to observe the program from multiple angles, using multiple methods, there remain many parts of the Outdoor School program that I never directly witnessed. First, my observations focused largely on the science learning and field study portion of the program. And while I always ate in the dining hall during meal times, and attended campfire each evening, I was less present in the cabin areas where much of the work to build communities between the sixth graders and student leaders occurs. In particular, I spent very little time in the cabin area that housed the female sixth graders and student leaders. I had very little direct contact with how these high school students were managing the miraculous transformation of groups of sixth graders into cohesive groups, and during my pilot study, I became increasingly convinced that the science teaching and learning I witnessed during field study could not be understood separately from this work of community building. Accordingly, it felt deeply important to find ways to invite these high school students to share their perspectives, and their insights into this aspect of Outdoor School that I had largely underestimated and undertheorized at the outset.

Interviews

As a researcher, it is one thing to discuss treating my experiences with a combination of skepticism and respect. Extending this treatment to the experiences of others, however, does not follow automatically. Indeed, the previous section details just how difficult it can be to shake off our habits to cede experience to external authorities, and to negate those experiences that don't conform with our attempts to limit meaning to

coherence with entrenched interpretive frameworks. When listening to the experiences of others, how do I navigate these habits? How do I avoid becoming the very source of authority that results in the ceding of experiences in the first place? And how can I prevent my own habits of meaning making from rendering the experiences of my research participants as meaningless?

In short, I want to begin with the recognition that I have no answers to these questions. They are not problems in need of solutions, but rather concerns that I welcome. They are important pebbles in my shoe, snags in my sweater, and engaging them does not require finding ways to reduce their perplexing presence. That being said, just as theory is an important component in learning to navigate the tensions surrounding my experiences as a researcher, I turn to theory again, not for an exhaustive answer, but rather for orienting and guiding my efforts towards listening to other people talk about something they care deeply about.

An emphasis on experience is a trait shared by pragmatism, intersectionality, and certain strands of feminism, relationships explored explicitly by Patricia Hill Collins (2011) and Charlene Haddock Seigfried (1996), respectively. And as Collins notes, placing frameworks like intersectionality and pragmatism in conversation with one another offers the possibility of enriching both:

> Intersectionality needs to develop a robust analysis of the importance of experience to its project and American pragmatism might provide the tools for such an analysis… Experience and speaking from the truth of one's own reality constituted an important dimension of Black feminism and its links to standpoint epistemology. In contrast, white men typically do not use their experiences in this way in doing intellectual work, such that the erasure of the social location of the intellectual becomes a signature feature of Western social theory, including pragmatism (p. 103).

Indeed, my choice to focus in the spring on the experiences of the many others who populate my site of inquiry is a response to my white male body, of occupying a position that has historically derived power by denying the reality of the experience of many others and marginalized groups. And, my identities as both an educational researcher, and someone who has significant experience with formal classroom science teaching, create the possibility of perceived hierarchies, even if I wish the case were otherwise. In particular, Outdoor School is often imagined as an "informal" education setting, one that sits on the margins of more sanctioned school experiences, and whose very success comes from a less rigorous set of academic demands. Moreover, Outdoor School tends to attract staff members who have themselves been marginalized by traditional schooling, as both learners and educators. My experiences as both a science teacher and a scholar of science education instill certain values about what constitutes compelling science learning and teaching. These values are important, and I don't wish to give them up; at the same time, worry about how they shape my interactions with others, creating constraints on both what I am able to hear, and what my research participants may feel able to say in my presence.

And if I worry about the possibility of perceived status differences when interacting with the adult staff members, this worry intensified when considering how to best interact with the high school students who volunteer as student leaders. These students are inculcated in a system where teachers know and students listen, where teachers transmit knowledge and learning is reduced in advance to the parroting of that transmission. I am a teacher, and was a teacher teaching in a school that some of these high school students currently attend. Old habits are difficult to shrug off, co-constructed

as they are by multiple agents in any single social setting, and they cannot be wished away.

So, how to proceed? On the one hand, these concerns shaped the location of my spring field research. I had initially imagined spending time at all three of the sites that Outdoor School operates in the spring, collecting data from a wider swath of research participants. However, after spending eight weeks at one site in the fall, I felt that I was just beginning to build relationships with staff members and the high school student leaders, relationships that might at least complicate the power dynamics I described above. That is, by working alongside staff and student leaders, my practical engagement with learning and teaching communicated my educational values and philosophies beyond spoken pronouncements of solidarity. On the other, as I experimented with creating interview practices that might honor the diverse experiences of my research participants, I again turned to theory as a polestar of sorts, and in particular, the work of Charlene Haddock Seigfried, as she ponders the question: "Who Experiences?"

Who Experiences? Genderizing Pluralistic Experiences

In her book *Pragmatism and Feminism: Reweaving the Social Fabric*, Haddock Seigfried explores the relationship between the philosophical traditions of American Pragmatism and feminism. She begins by reconstructing the history of pragmatism in a way that acknowledges its tremendous debts to women thinkers, and traces the influence of feminists like Ella Flagg Young, Elsie Ripley Clapp, and Jane Addams on the thinking of John Dewey in particular. And while Haddock Seigfried notes that such influences are rarely acknowledged either by Dewey or later historians of Dewey's work, their thinking

remains integral to his larger philosophical project. Further, like Collins, she argues that the promise of pragmatism as a philosophy that honors pluralism and fights against oppression remains empty so long as its philosophical projects remain unmoored from the particulars of being in the world:

> A broad theory of oppression and pluralism is helpful but not sufficient. As pragmatists should be the first to recognize, only concrete analyses can provide satisfactory or worthwhile outcomes… For pragmatists, it should be an epistemological as well as an ethical issue and evidence of a flawed methodological procedure that relevant groups of people are simply missing in philosophy and that many diverse and challenging perspectives are marginalized or absent" (p. 108).

To begin, Haddock Seigfried acknowledges that "appealing to experience is problematic on many levels" (142), attending to the important work of contemporary feminists and other theorists who have deeply troubled the deployment of any static category of identity. However, she argues that pragmatism locates the traits of experience within the flux of historical processes, and not within predetermined natural categories—"We are not contemplatively detached from experience, but are ourselves formed within it as 'desiring, striving, thinking, feeling, creature(s)'" (p. 144). While an emphasis on experience is often seen at odds with poststructural and posthumanist methodologies that insist on a decentering of the subject, it is important to remember that in Dewey's definition of experience, he explicitly counters "the assumption that experience centers in, or gather about, or proceeds from a center or subject which is outside the course of natural existence, and set over against it" (p.74). Dewey's understanding of the relationship between the human and the natural world is deeply influenced by the work of Charles Darwin, and while it is beyond the scope of this paper, it is interesting to note that Stacy Alaimo, a feminist scholar interested in what she calls

the nonhuman turn in feminism, writes that "Darwin's 1871 *Descent of Man* may well be the founding text of posthumanism" (2013, p. 390).

Like Colapietro, Seigfried points to the problematic consequences of modes of philosophy that value the cognitive aspects of experience over all others. That is, many of the perceived problems with experience emanate from a philosophical tendency to value the objective nature of epistemology over and against the subjective world of experience, where the only traits of experience worth attending to are those that explicitly fit the cognitive dimension. In a socio-historical context where rationality and objectivity have largely been attributed to males, while the experiences of women and people of color have been disparaged as overly subjective, forging a theory of experience that refuses the hierarchical impositions of epistemology feels important. Seigfried recounts Dewey's efforts to demonstrate that rationality and logic are consequences of particular ways of thinking and inquiring, and not inherent qualities that we should use to evaluate our experiences in the world. In doing so, he exposes particular hierarchical dualisms that have marred philosophical efforts at theorizing experience, and importantly, Seigfried notes that these same dualisms are also central obstacles to feminist projects working against entrenched structures and habits of oppression:

> (1) the depreciation of doing and making and the overvaluation of pure thinking and reflection, (2) the contempt for bodies and matter and praise of spirit and immateriality, (3) the sharp division between practice and theory, and (4) the inferiority of changing things and events and the superiority of a fixed reality. (p. 146).

First, I recognize that the historical constructions of whiteness and maleness that swirl around my body derive power by claiming the second position in each of these dualities precisely by locating all things female and nonwhite with the first. My desire to

craft a methodology that refuses to re-entrench these hierarchies is also a desire to recognize how my own body is entangled with structures that have denigrated the experiences of others in the past. As such, an emphasis on the experience of my research participants, and an emphasis that refuses to couple ontological weight and reality with epistemological certainty, is an effort to push back against the local manifestations of power and privilege that follow me into my project of inquiry.

Second, just as these dualities have been used to disparage and suborn the experiences of women and people of color, they also fit the dualities we construct between youth and adults. The very process of schooling can be imagined as one that encourages growth towards one side of these dualities, and away from the other. Teenagers in particular are often seen as overly impulsive and insufficiently reflective, ruled by bodily passions rather than rationality, and beings whose status of flux marks them as unreliable narrators of their own experiences. And yet, this Outdoor School program would grind to a screeching halt if not for these teenage volunteers, and their willingness to take on heavy mantles of responsibility, and who practice unconditional love for groups of sixth graders they have never before met. Indeed, the role that high school volunteers play in this particular Outdoor School program is one of its most unique features, the thing that makes this program so decidedly different from other iterations of overnight outdoor learning experiences that exist across this country. [quotes from interviews about this?]

Finally, these dualities are also associated with the binary we create between contexts of formal and informal learning. Indeed, the term "experiential learning" has often been used as a contrast with forms of learning that are deemed more rigorous,

intellectual, or cognitive in nature. And, many of the staff members who work at Outdoor School are doubly disparaged by this system of binaries: they tend to be young individuals, and few have completed the formal schooling we demand of professional educators. Indeed, science education research in particular has a history of relying on the opinions and views of specialists, including scientists themselves, to critique the insufficiently authentic presentation of science learning in traditional classrooms. My decision to dedicate much of my spring field investigation to the collection of interviews with both staff members and the high school student leader volunteers felt like an important part of resisting this problematic historical critique of science education, and the narrow framing imposed by an emphasis on epistemology. Indeed, the hope that the empirical methods at the heart of science will bring about a radical form of democracy is forever stymied by a system that values that from the outset values the experiences of some bodies over those of others. Accordingly, I hoped that "The monopoly of more specialized forms of knowing can be broken by turning to the ways that…persons in everyday life manage to solve problems and thereby extract knowledge from their daily concerns (Seifgried, p. 148)"

Interview Methods

The participants I recruited to take part in interviews belong to two different groups: staff members who worked at all three Outdoor School Sites during the Spring of 2016, and the high school student leaders who volunteered at the site where I conducted my pilot study in the fall. In order to facilitate the interviewing of student leaders, I continued to reside on site each week from Sunday through Friday during each of the twelve weeks the program runs in the spring, with the exception of missing two half

weeks to attend conferences. Protocols for interviews can be found in the appendix.

Participants and Recruitment

Adult Staff Members

Each Outdoor School site has eleven staff members: four field instructors, three male-identifying program leaders, three female-identifying program leaders, and a site supervisor. All staff members are over the age of eighteen. The majority of them are in their twenties, with a handful of individuals in their thirties. Before the spring session began, staff members from all three sites gathered together to take part in a two-day professional development retreat known as consortium. I requested and was granted an hour and a half long time slot during consortium, where I was able to talk with staff members about my history with the Outdoor School program, my experiences teaching high school science, and a more recent project where I collaborated with colleagues, inquiring into the work of preparing anti-oppressive educators in the university setting. I was joined by one of my colleagues at consortium, where we shared some of the preliminary results of our inquiry, emphasizing how the work of teaching towards social justice was necessarily embodied, involves opportunities to practice, and is a project requiring constant navigation, with no fixed end. Because all staff at Outdoor School are also engaged in the process of mentoring and supporting the development of the high school student leaders, as both leaders and educators, I hoped that this process of sharing would underscore a common set of commitments, and help to make public my own values, and why the work of Outdoor School mattered to me. Following this presentation, I distributed informed consent forms, and made myself available for

questions. In total, all eleven staff members from the site where I conducted my pilot research returned their informed consent forms, indicating a willingness to take part in interviews. At the other two sites, I received eighteen consent forms indicating a willingness to be interviewed. I never received consent forms from the remaining four individuals.

Conducting these interviews proved challenging. Even with the staff members I lived with on site, there are very few times between waking up at 6:30 and going to bed around midnight to schedule interviews. Instead, I scheduled a variety of group and individual interviews with staff members to take place on Saturdays, their one day off each week. This felt like a huge thing to ask, and possible mostly because of the relationships I had established with these individuals in the fall. In total, I conducted six individual interviews, and four group interviews, with the eleven staff members who worked at the site where I lived in the fall and spring.

I also spent one half week at a second site in the spring, where I played the role of a special needs volunteer, supporting a group of 6th graders with limited English skills. This did still provide me with an opportunity to build relationships with the staff members, and during that half week I was able to conduct five interviews, three individual and two group interviews, with a total of eight individuals. I was unable to spend any time at the third site, and had a difficult time finding time on the limited Saturdays to set up interviews. I was in email contact with four individuals from this site, and only managed to conduct one individual interview with this set of staff.

Student Leaders

Student leaders are high school volunteers who the Outdoor School program recruits from public and private schools in and around the Multnomah County area. Student leaders must be sophomores in good standing, which essentially means that their guidance counselors are willing to sign a form indicating their eligibility. The site supervisors, who are year-round staff, visit high schools during both the fall and early spring, where they hold informal meetings after school and during lunch to provide interested students with information. In addition, successful student leaders from previous years can sign up to be recruiters at their high school, and may hold additional informational sessions, and assist in passing out the information cards that students send in to indicate their interest in volunteering.

When students submit theses cards indicating their initial interest, they also mark their choice of the site where they hope to volunteer. All students who submit these cards are then invited to attend an initial weekend-long training session, which also doubles as an opportunity for staff to identify any students who they feel may not be ready for the tremendous challenge of teaching and leading groups of sixth grade students. Many of these high school volunteers were sixth graders at outdoor school themselves, while some have been pulled into the program by friends, and still others at the recommendation of teachers and counselors. This workshop begins after school on a Friday, and the high school students spend the night on site, as well as most of the following day.

The training encompasses both the leadership and child management responsibilities that will enable these students to successfully care for a cabin of sixth grade students, as well as a component of teacher training, as the high school student leaders are also the ones who do the majority of the science teaching during the program.

During that Friday night dinner of workshop, each of the four field studies—animals, plants, soil, and water—put on a brief presentation that introduces students briefly to the type of content that will be covered, and perhaps more importantly, to the personality of the staff member in charge of each field study. At the end of these presentations, I also spoke for a couple of minutes about my research, and told the students that I believed my inquiry would be incomplete without including their voices and experiences. I let these students know that their participation was voluntary, and that for those under the age of eighteen, they would need to bring with them an informed consent form with a signature from a parent or guardian.

These consent forms were included in packets mailed to all student leaders who were assigned a week at the site where I resided. The student leaders were then required to bring this signed consent form with them to site on Sundays when they showed up for their week of service. The high school student leaders submitted these forms along with a medical form they were required to bring upon arrival. Student leaders also choose Outdoor School names first thing after arriving on Sunday afternoon, and fill out a sheet that enables their real names to be matched with their chosen camp names. I used this in conjunction with the consent forms to create a list of student leaders by Outdoor School name who could elect to participate in interviews. Signed consent forms were kept in a secured location on site for the duration of the spring, and using Outdoor School only in my subsequent interview documentation and transcription enabled me to better protect the privacy of these participants. On Sunday evenings, student leaders meet with the program leaders for a meeting after dinner, and I made myself available during this time for student leaders to sign up for 45 minute group interview sessions. Over the course of

the 9 week spring session, I conducted a total of 16 group interviews, with groups ranging from two to five students per interview, with sixty six participants in total.

Interview as Craft

Before undertaking the delicate work of interviewing, I spent time with Brinkmann and Kvale's (2015) text *InterViews: Learning the Craft of Qualitative Research Interviewing*. The authors discuss the multiple and sometimes conflicting approaches to interviews in qualitative inquiry, and note two general orientations to the work. On the one hand, they recognize "the methodological positivists' idea that strict adherence to certain prespecified rules is a truth guarantee in science" (p. 71). On the other, they discuss the work of interviewing as a craft, where "[b]y craft and craftsmanship we refer to mastery of a form of production, which requires practical skills and personal insight acquired through training and extensive practice" (p. 73). This conception of interviewing as a craft felt much more commensurable with my larger methodological project, and while I developed interview protocols to guide this work, such protocols were often under experimentation, and sometimes abandoned altogether.

For example, I conducted my first staff member interview with an individual who worked at the site where I was living and conducting field research. I knew this individual rather well, and we had discussed his philosophy of teaching and learning extensively in informal conversations before the formal interview. However, when we sat down together one Saturday morning during the spring session for an interview, the resulting conversation felt flat. That is, his responses that morning lacked both the passion and specificity of previous conversations we had had. And he noted this too,

telling me at the end of the interview that he felt really tired, which is hardly surprising considering given how hard staff members work during the week. I also recognized that the prior conversations I judged this interview against had always occurred in small groups. Consequently, I invited this individual to engage in two additional group interviews. In the dialogues that ensued in these group settings, this individual's responses to questions evoked greater detail and specificity, and felt more resonant with the work I had observed this individual perform during the daily happenings of the Outdoor School program.

This is not to suggest that the subsequent group interviews better captured some true and final essence of this person. As Brinkmann and Kvale emphasize, researchers often imagine a "universal authentic self to be revealed through personal narratives in the context of the interview, but what is overlooked is the possibility…that interviewee subjectivity is not so much *revealed* as *constructed*" (p. 107, emphasis in original). It is not surprising, then, that the subjectivity that emerged during a formal individual interview would differ from that which I had come to expect during informal group conversations. This is not to say that one of these versions of the interviewee's subjectivity was more authentic than the other. Rather, I hoped that the interviews with staff members would help me to capture some of the conversations that I had witnessed during my time in the field, and because many of these conversations were social in nature, the group interview setting produced a similar subjectivity. Indeed, one of the common threads that emerged during interviews with both staff and student leaders concerned Outdoor School as a site where people and groups could experiment with their identities, both individual and collective. That is, my research participants spoke of the

many ways that the experience of Outdoor School had resulted in personal transformations, serving as a reminder that subjectivity is always in the process of becoming. In turn, my experiences with these interviews instigated a shift in how I began to conceptualize the work of Outdoor School more broadly.

Outdoor School Beyond the Subject/Object binary

Throughout the course of my inquiry, I wrestled with how to understand the set of practices and values that circulate in this Outdoor School program. In other words, what type of being is Outdoor School? Indeed, much of my attraction to the field of science studies, and the work of Karen Barad and Bruno Latour in particular, came from this tradition's dissatisfaction with traditional categories of inquiry like subject and object, material and discursive, and nature and culture. Outdoor school felt like an association or assemblage of many heterogeneous elements, and prior to my field research, I was attracted by Barad's notions of agential cuts, and of phenomenon that emerge given the complex intra-actions between human and non human agents. However, during my fall pilot study, when I tried to think with Barad in order to understand what I was witnessing and observing, I felt dissatisfaction and disconcertment, evidenced in one particular entry in my field notes:

Despite overt attempts to diminish the human centric focus of our understandings of science, and inquiry more broadly, Barad's discussion of agential cuts, and the role of both humans and non-humans in creating the conditions that make certain possibilities crystalize at the loss of others, offers very little room for talking about the roles of communities in acting as agents. In other words, her discussion of Bohr's experiments with light, or the role of cigar ash in that other experiment, cements the notion that agency arises from the intra-actions between solitary human experimenters and the non-human pieces that make up the material conditions of the experiment. This leaves untroubled the notion that science is an activity engaged in by solitary humans, and

makes it difficult to understand how multiple agential cuts may be enacted by communities of individuals, some with different normative assumptions and ways of being in the world.

Further, when Barad's notion of agential cuts is used to understand the role of the researcher in qualitative inquiry, it is difficult when the inquiry itself blurs the lines between naturalistic observations and experimental intervention. While I am convinced that we need to recognize that we as researchers are always already intervening, both in our actions and our attempts at description and representation, there seems to be an unspoken recentering of the human when we focus so much on how our own agency is responsible for determining the situations into which we inquire. As I have been observing and intervening with the staff at ODS, I am constantly reminded of the tremendous agency of both the individual staff members, and the ways in which they function as a collective working towards common ends-in-view. Sometimes the commonality of such ends is the overwhelming apparent source of agency, and the parts disappear into a cohesive whole. At other moments, the individual assumptions, values, and experiences of different staff loom large, and all of this changes over time as the program progresses each week, and in response to different groups of students, different problems and challenges that emerge.

In other words, in trying to make sense of what I was witnessing in this educational setting, a thing that involved agents that ranged from individual humans to collectives to non-human plants and animals and the environment more broadly, I felt mostly stuck. Though it was clear that part of what I was observing at Outdoor School was the agency of place, a different enactment of cuts than those I anticipate in more traditional classroom settings, this wasn't a direction that felt entirely compelling or possible given my methods. The sixth grade learners themselves were not the focus of my inquiry, and I was not attempting to construct a new model of science learning at the level of individual cognition. Instead, I was inquiring into the practices of Outdoor School in order to engage in a dialogue about the aims of science education, the usefulness of conceptions of scientific literacy that moved away from a transmission model, and this larger question of what, if anything, science education has to do with the promotion of social justice. To do so, I chose to focus on the side of production, of the

enactment of these practices by both staff members and high school student leaders. This is not to say that a focus on how such practices are being received by the sixth grade learners is either impossible or irrelevant. It is simply not the focus of this inquiry.

An important thread that runs through the scholarship of those I have brought together here is the insistence on putting our theoretical imaginings to work through concrete application and analysis. My project, then, attempts to place compelling novel ideas about scientific literacy in conversation with these practices, as a practical test of sorts, to find push the limits of theory, and to extend theory in new directions. Part of this work requires picking up new theories when those we carry with us initially begin to break down. During my pilot study in the fall, I realized that much of what I was documenting was not the agency of place per se, but the ways in which staff and student leaders differently mobilized place in their interactions with sixth graders and each other. Such mobilizations are deeply heterogeneous affairs, and despite my best intentions, I found myself clinging to a conception of place that held intact an overly romantic nature, one that, because it excluded the social and the cultural, also reified those as separate categories of analysis.

In the midst of this disconcertment last fall, I picked up Bruno Latour's *An Inquiry into Modes of Existence: An Anthropology of the Moderns* as I realized that, despite my fascination with the posthuman turn in social inquiry, my work in the field resembled the ethnographic methods of anthropology. And in this text, Latour takes up a fascinating fictional dialogue with an anthropologist who is seeking to study us moderns who have never in reality been modern. That is, in Latour's earlier text, *We Have Never Been Modern*, he demonstrates how the values of modernity that we espouse do not in

any way cohere with our practices: we talk about a world neatly divided into categories like object and subject, natural and cultural, scientific and political, while we daily engage with beings whose messiness defies all such attempts at categorization. Latour's earlier efforts to provide a different analytical framework for making sense of these messy quasi-objects resulted in the establishment of Actor-Network Theory. Here, Latour recognizes an important flaw in the analytics of Actor-Network Theory— though the concept of network enabled the study of heterogeneous associations, it was unable to account for the diverse sets of values that distinguish one network from another. And so Latour asks, of this hypothetical anthropologist with whom he is conversing:

> What can she do to hold onto both forms of diversity, the first allowing her to remain attentive to the extreme heterogeneity of associations, the second allowing her, if only she has the right tool, to *determine* the type of value that seems to circulate in a particular network and to give it its specific tonality? p. 36

Importantly, Latour recognizes that descriptions themselves can belie the existence of different sets of values, values that may disappear when we filter our inquiries through concerns of epistemology alone. And while the disappearance of such values may be an essential component of our modern attempts to describe the world objectively, the loss of these values, and other aspects of our experiences with diverse worlds that don't conform to the molds of cognition, was precisely what my methodological approach sought to prevent. And the words of my research subjects were replete with emotion, with politics, with aesthetics, and I didn't want to loose hold of these aspects of the Outdoor School experience by forcing them through a mode of description whose objectivity rested on their removal. Here, I was compelled by Latour's recognition of just "how difficult it is to learn to *speak well to someone about something that really matters to that person*" (2013, p. 46).

One of the common sentiments I heard during my interviews raised a related methodological tension. On the one hand, many of my research participants were deeply compelled by the importance of sharing the Outdoor School experience with others, of making these practices public. On the other, my participants felt that any attempt at describing Outdoor School would inherently reduce the complexity of these practices. Indeed, Outdoor School played an almost mystical role in the narratives of many of my participants, and they seemed to worry that any attempt at producing a final and authoritative description of the program would simultaneously profane their complex experiences. While I am skeptical of any and all binaries, including one that positions some things as inherently sacred, and others profane, I did not want to dismiss the weight of this experience. To position Outdoor School as an *objective* experience threatened to ignore these values, while to understand the transformations this program seemed to engender as *subjective* threatened to remove any ontological weight from the experience all together. In other words, Latour's goal of describing multiple modes of being, modes of being that entail both heterogeneous associations and the circulation of distinct sets of values, felt deeply related to my project.

Indeed, Latour's work seeks to take advantage of the plurality of beings that begin to emerge when we release them from "the crushing division between Object and Subject" (p. 182). Accordingly, rather than the procrustean efforts of forcing the emergent phenomena of inquiry into the established categories of object and subject, Latour seeks to identify multiple modes of being that are better suited to the plural ways we experience and interact with our worlds. And for every mode of being Latour identifies, he marks the need to "ask what specifications their ontology must respect and

what their 'essential requirements' are" (182). Such recognition requires three methodological moves: recognizing that all continuity is also comprised of discontinuities and hiatuses that are both to be expected and interrogated; recognizing that each set of discontinuities and hiatuses make sense given their own set of felicity and infelicity conditions; and recognizing that there are right and wrong ways to "grasp the mode" (182). And in exploring Latour's attempts to describe the felicity and infelicity conditions of different modes of being, such that we are able to respect the beings of experience, I was struck by how much Outdoor School resembled what Latour calls a being of metamorphosis. That is, nearly all of my research participants, student leaders and adult staff members alike, spoke of Outdoor School as a vehicle of change and transformation, both in terms of their selves, and for the sixth graders the program purportedly serves. There is an undeniable aspect of ritual in the practices of Outdoor School, an aspect that felt impossible to recognize as an important element in science learning given our habits of imagining the two to be polar opposites—if science is about external reality, and rituals about subjective experience, what can the one possibly have to do with the other?

In order to make sense of these new questions that arose, and the new ways that I began to think about both the particulars of my research site and the questions that I carried with me that guided and framed my modes of inquiry, I find myself needing to step back again for a moment.

Outdoor School as Being of Metamorphosis

> It is clear that this experience—of shock, alienation, detection, transformation, installation—is at once very common and very difficult to qualify within the

> narrow framework of psychology. The continuity of a self is not ensured by its authentic and, as it were, native core, but by its capacity to let itself be carried along, carried away, by forces capable at every moment of shattering it or, on the contrary, of installing themselves in it. Experience tells us that these forces are external, while the official account asserts that they are only internal—not, that they are nothing. Nothing happens. It's all in our heads. One thing is certain: we have here a form of continuity that is obtained by leaps, by passes, by hiatuses through a dizzying discontinuity. And thus we have, as a first approximation, an original mode of existence that we shall note from here on as METAMORPHOSIS" (196).

Latour begins his exploration of the multiple modes of being that emerge when we release ourselves from the necessity of the object/ subject divide by describing two modes of being that he argues represent the poles of this schism: the beings of superstition and ritual that seem the most immaterial of all, and the beings of technology that we moderns imbue with a sort of hyper realism. In doing so, we "attempt to rediscover the thread of two experiences, one overly negative and the other overly positive, whose oscillation very largely determines the anthropology of the Moderns" (need page number here). Latour notes that while many other societies and cultures have created institutions and habits that honor those immaterial beings whose role is nonetheless crucial, our modern constitution renders them as utterly irrational, thus preventing their institution. That is, we attempt to defend our own hold on modernity by destroying and rendering inconsequential the fetishes that we believe keep nonmoderns in a state of primitive beliefs and religious attitudes. Importantly, Latour suggests that "the Moderns lack an adequate way to grasp those beings to which the other cultures pay so much attention" (184), and because we lack an adequate description of these immaterial beings, we disparage them, and pathologize those who treat them as real.

Because the moderns so narrowly define the world of external reality—as neutral, inert, rational, uniform, causal, etc—they are forced to also adopt and define an internal region of subjectivity to locate all of the things that don't fit in this narrow description:

> Unable to discharge or even to situate a set of phenomena that are quite real, quite objective, quite fleshed-out, but that do not resemble what was anticipated in the too-quickly-saturated vessel of exteriority, the Moderns could be said to have gotten rid of them, there's no other way to put it, by calling them 'internal to the subject'" (188).

In other words, Latour recognizes that the very belief that these beings are immaterial stems from a particular conception of what counts as matter in the first place. So when Modern anthropology failed to be able to locate these beings responsible for change and transformation, beings often found in ritual and ceremony, in the material realm, they have been cast into the inner realm of the mind, through the intermediary of psychology. "Indeed, we are going to discover that psychology plays the same role among the Moderns as epistemology, but in inverted fashion: whereas the latter exaggerated the outside world, the former overplays the inside world" (p. 185).

Here, we face another methodological question: how can we treat these experiences of change and transformation, of "an experience that the accounts that have become official succeed only in squelching?" (190). How can I speak of them in ways that honors their mattering, especially to the people for whom they matter? How can I re-present these experiences without stripping them of their ontological weight?

CHAPTER IV

LATOUR'S BEINGS OF FICTION

Between the fall and spring portions of my field research, I witnessed more than twenty iterations of this Outdoor School program. Each iteration typically serves between 100 – 150 sixth grade students, meaning that I observed well over 2000 sixth grade students engaged in this learning environment during the course of my inquiry. Similarly, over the fifteen weeks of my observations, I saw fifteen different groups of high school students perform the work of student leaders. These students attend schools from eight different public school districts that range from urban to rural, with racial and socioeconomic demographics varying widely from school to school and district to district. Finally, this multiplicity represents only one third of all the Outdoor School experiences that transpired during the 2014-2015 academic year, as the program runs at three different sites. So when it came time to begin to craft a series of stories that evoke the experiences that unfold during this program, I had a hard time knowing how to hold onto this multiplicity in my writing. In particular, very few of the stories I tell about the teaching and learning draw from single experiences or incidents; instead, they are the products of both the many iterations of teaching and learning that I observed, as well as the versions I heard discussed in interviews with staff and student leaders.

I imagine this collection of experiences as producing multi-dimensional worlds, set in motion through time by the unfolding of each iteration of the program. While each iteration is clearly distinct, they all share in a common structure imposed by the schedule and by the space itself, and so can be laid on top of one another, amalgamated, into a swirl of happenings that correspond to different moments in a single program. So when I

ask myself, "What are the experiences of students arriving?," I enter into an amalgamation of experiences that are both stable and precarious—stable enough to provide an answer, but not one that is definitive nor comprehensively exhaustive. The stories are neither entirely composite nor entirely singular, and build from both the repetition of witnessing some of these elements more than twenty times, and the singular events that loom largest in the landscapes of these experiences.

My process of storytelling involved attempts to enter into particular moments in time and space within these experiences, seeking to evoke plants field study on a Monday morning, or the experience of breakfast on Wednesday morning. I wanted to evoke interactions that held onto the multiplicity of actors, and the iterative nature of my field research, as these interactions played out over and over again, across time and space and bodies. In the many choices and dilemmas I encountered, I continued to think with Latour, as his *An Inquiry into Modes of Existence* also offers guidelines for respecting beings of fiction. Because this is an understanding of fiction that is a unique departure from more conventional uses of the term, I need to pause for a moment here and fill in some theory before getting on with the stories.

Latour's beings of fiction require an understanding of fiction not simply as an epistemological category positioned as the opposite of all things factual, but rather an ontological category, a specific mode of being in the world. Importantly, Latour recognizes that our obsession with epistemology, and lack of attention towards ontology and being, leads to a particular conception of the relationship between words on the one hand, and worlds on other:

> Inevitably, we risk falling back on the idea that there is, on one side, that which exists, and, on the other, 'representations' of that which exists. In this view, existence would always be a unity; representations alone would be multiple" (p. 234).

Importantly, this is precisely the same schism that Latour (2004a) confronts in *The Politics of Nature,* when he recognizes that the proliferation of multiculturalism has stemmed largely from the insistence on a singular nature, and part of his larger move towards multinaturalism requires a simultaneous broadening of the categories of being, or modes of existence, that populate our plural worlds. Latour writes that "A mode of existence is thus always both a version of BEING-AS-OTHER (a debiting of discontinuity and continuity, difference and repetition, otherness and sameness) and also its own regime of veridication" (pp. 182-3). While modes of existence may all produce networks of associations, the rules that govern such associations differ from one mode of being to the next. Too often, we naturalize and thus ignore the rules that enable objective knowledge to form seemingly solid relationships between words and worlds, forgetting that objective knowledge is also full of leaps, discontinuities, and hiatuses that only fade into the background because we have elevated the rules that govern them to the status of a universal Logic. And, when we impose this same logic on the beings of fiction, we charge the networks they create with being subjective, possessing a reality that is entirely interior and separate from the world of objects and knowledge.

Accordingly, respecting multiple modes of existence requires that our methods of inquiry recognize that different modes of being possess unique logics, and proceed along

discontinuities and hiatuses that are to be both expected and interrogated; that each set of discontinuities and hiatuses make sense given their own set of felicity and infelicity conditions; that there are right and wrong ways to "grasp the mode" (Latour, 2013, p. 182). That is, by describing modes of being in the plural, we can once again "cut out a template capable of respecting the singular experience that each one offers" (p. 234). To do so, we must evaluate beings of fiction in a new way, through a different template of objectivity:

> Fiction is not fictional in opposition to 'reality' (which in any case possesses as many versions as there are modes), but because as soon as those who are being displaced loose their solicitude, the work disappears entirely. This is indeed objectivity [FIC], but in its own mode, which requires being taken up again, accompanied, interpreted (249).

That beings of fiction give rise to multiple interpretations doesn't simply signal the existence of multiple perspectives or multiple descriptions of the world. Instead, it serves to emphasize a multinatural ontology, one where worlds themselves are multiple. It is only when the objective world of matter is conceived of as singular, inert, mechanical, and lacking in values both aesthetic and political, that fiction becomes inherently subjective, unreliable, and located only in the minds of individuals.

Rather than position fiction in a dichotomous relationship with objective knowledge, Latour describes the different types of networks each mode produces. In other words, beings of fiction are not simply placed in a new binary relationship with beings of reference; instead, these are two modes of being among many that Latour describes in reaching towards ontological plurality. As much as these two modes of being are distinct, they also share similarities. Both involve trajectories and movement, and the creation of new connections, and beings of reference often rely of beings of

fiction—that is, "no chain of reference can be established without a *narrative* populated by beings who can come only from fiction;" however, the beings of reference "are distinct from the beings of fiction in one way: they have to *bring something back*" (251). This distinction is greatly similar to the one that Dewey makes between having and knowing an experience. Having an experience, like a being of fiction, involves a disruption and a movement that is entirely unpredictable, and importantly, both are productive of multiplicity. Just as no two people will have the exactly the same experience of seemingly singular events and occurrences, we shouldn't expect a singular and authoritative interpretation from engaging beings of fiction. Knowing an experience, on the other hand, or interacting with beings of reference and knowledge, is similarly productive of movement, but ends in a common point of return, marking selections that enable us to carry part of that experience back into the process of inquiry. And while I will eventually engage in the work of knowledge production, of domesticating the diverse happenings of Outdoor School by sifting them through a particular process of selection, I use fiction first to re-present the multiplicity of experiences that tend to be erased when we leap to knowledge too quickly.

Indeed, it is by more patiently and carefully attending to the contours of experience that we come to recognize the problematic positioning of beings of fiction as wholly subjective and interior to the minds of humans:

> Without any doubt, there is some *exteriority* among the beings of fiction: they impose themselves on us after imposing themselves on those responsible for their instauration, for the latter are more like constituents than 'creators'. They come to our imagination—no, they *offer* us an imagination that we would not have had without them" (p. 240)

This distinction is greatly important to my project. First, it serves as a reminder that the stories I seek to tell are not mine. I did not create them; instead, I am a constituent, a co-agent only partly responsible for their instauration, their process of becoming. Indeed, it is impossible to point to any singular origin of these stories. They arose from the comingling of my participatory observations, interviews, my previous experiences, and the interpretive frameworks I use to understand the events unfolding around me. If these stories lack a singular origin or agent of genesis, they also remain unfinished until they are taken up again by other agents in the act of reading. And since I understand this project of inquiry as an act of diplomacy, I believe that evoking the complexity of ODS through beings of fiction makes it more possible that the following stories will not simply describe the importance of this learning and teaching to scholars and educators being introduced to this program for the first time, but also to the many actors I engaged with during my research, those who make the program possible in the first place.

Finally, Latour announces that "[m]aking room for the beings of fictions amounts, paradoxically, to authorizing ourselves to be materialists at last" (252). That is, Latour's beings of fiction offer a different sense of semiotics then the one we inherit from structuralism, with the problematic gap between sign and signifier that seems to render meaning so problematic. Rather than locate meaning in the realm of epistemology and knowledge, where the world itself is mute save for the system of signs and symbols imposed by human beings, Latour understands meaning as an ontological property of worlds that are constantly in the process of articulating:

> the sign is 'arbitrary' only for those who, having agreed to lose the experience of relations, try to reinject relations on the basis of the 'human mind' into a 'material world' that has been emptied in advance of all articulations. Now, as we are beginning to understand more clearly, it is *the world itself that is articulated*…

> Give existents back their ins and outs, what goes before and what comes after, and you will find that they are full of meaning, that they collect many differences besides that of the 'minimal pair' dear to advocates of structure, that they register the world's alterations admirably well" (256).

In other words, as I remarked earlier, the ontological commitments of my method match those of my theoretical framework. Mononaturalism was made possible by an onto-epistemic paradigm where meaning was both singular and imposed on nature by human minds alone. In order to imagine a scientific literacy engaged with multinaturalism, we must replace a singular and mute nature with multiple worlds constantly in the process of articulation, capable of speaking not just to the singular class of scientists, but to any being willing to listen, to learn, and to respect worlds already overflowing with meaning.

CHAPTER V

ARRIVALS

Sometimes Outdoor School feels like a never ending circle, like *Groundhog Day*, like samsara. Every Sunday four school busses pull down the long driveway, flanked by old growth Douglas Fir trees, and staff and student leaders greet each bus with their first taste of Outdoor School's propensity for song:

We welcome you to Outdoor School, we are mighty glad you're here
We'll send the air reverberating with a mighty cheer
We'll sing you in, we'll sing you out
To you we raise a mighty shout—Hooray!
Hey, hey, the gangs all here,
Welcome to Outdoor School!

Staff and student leaders line each side of the bus, so sometimes the song begins and ends at two different times, while the faces of sixth grade students press against the window, sometimes with cautious smiles, and sometimes with something much closer to terror. For many of the sixth graders this will be there first time away from home, from parents, from regular routines, and from the ins and outs of regular school, which I suppose can feel a bit like samsara, too.

After the welcome song, the site supervisor gets on each bus and delivers a slightly more formal welcome, and informs the sixth graders of what will happen next: They will pile off the buses, and find a student leader who will bestow upon each of them their very own wood cookie.

"A what?" precocious students are wont to ask.

Ahh yes, the wood cookie. These small disks of wood have been fashioned by cutting cross sections from branches, resulting in wooden disks that are typically three or four inches across, and a quarter of an inch thick, with two small holes drilled for the top so that they can be placed on pieces of string and become necklaces, nametags, signs of belonging. Everyone at outdoor school wears a wood cookie. And so the site supervisor holds up her own wood cookie and explains to the sixth graders that one of the important rules of Outdoor School is that everyone will wear their wood cookies at all times. Written on both faces of each wood cookie are students' first names and last initials, as well as an abbreviation indicating what school they are from. Soon, the wood cookies will also gain stamps that indicate which cabin students are staying in, and beads as they complete different field studies and interact with student leaders, and on the last day of Outdoor School sixth graders will have an opportunity to have staff and student leaders sign their wood cookies, so that when they leave Outdoor School they are able to carry with them this physical object that represents their experience. On the one hand, these wood cookies are part of the problematic appropriation of Native American traditions that are all too common among summer camps and engagements with nature alike. On the other, they enable all members of the community to begin immediately calling each other by name, an act that is certainly part of this program's ability to foster a sense of familiarity amongst so large a group of strangers.

When the site supervisor finishes the first of her many speeches, the sixth grade students shuffle off the buses, leaving their gear behind, and meet one of the student leaders holding a bundle of wood cookies, ready to take a group of students on a tour of

the site while other staff and student leaders unload the buses. Each sixth grade class typically has somewhere between 20 and 30 students, and in order to create more manageable groups, students are separated by gender: a male student leader gathers all the boys, and a female student leader all the girls.

I stood outside the bus of one of the bigger classes and assisted a student leader tasked with distributing and tying the wood cookies around each of the sixth grade boys' necks. There is a nervous energy in the air, and the boys jockey and jostle as they wait to receive their medallions, and have to make the difficult decision whether or not to accept the help that I offer. The sun shines brightly on this clear fall day, and these students are less than 2 months into their sixth grade years, new to middle school, and in that strange liminal space that accompanies those years. Not quite kids any more, certainly not adults, and often in the process of exploring and experimenting with personal identity.

"Who am I today?" you can almost see students' asking themselves as they look around at this new space, and perhaps more importantly, "who can I be?" And the possibilities entailed in this question are certainly part of the anxiety that seems almost a ubiquitous part of the middle school experience. In part, these questions of identity emerge from the foreign nature of the space, and also from another question that is on many of their minds: "Where we will be sleeping? And with whom?" Students are told that they will be separated into cabins, where they have at least one other person from their class, and will join strangers from the three other schools. This is clearly an anxiety producing bit of uncertainty, and students deal with it in different ways. Some are brash and bold, others quiet and subdued, twisting and adjusting the newly acquired wood cookies that have a strange weight to them, as well as a strange vulnerability that comes

with being so visibly named, and thus capable of being hailed. I always laugh at the puzzled faces of students when I call them by their first names before any formal introductions, before that moment of understanding as they look down at the labels they have just received.

Once these groups of students have their wood cookies around their necks, they are led by student leaders on a tour of the site, visiting the main shower house, the nurse's station, and finally the cabin area where they will eventually be staying. Much of this tour is a stall tactic, while the teachers from the four schools meet with several of the program leaders and the site supervisor to determine cabin groups, or which students from each school will be in each of the six cabins located in each of the two cabin areas. And each cabin will also be assigned one or more of the high school student leaders, who will become largely responsible for the group of sixth graders placed in their cabin during the remainder of the program. This granting of responsibility, placing the well being and safety of sixth graders squarely on the shoulders of high school students is one of the unique aspects of this program, and that it works remains a surprise to many outside observers.

Depending on the timing of the buses arrivals, the game of tour and stall took anywhere from thirty minutes to well over an hour. While buses were supposed to arrive in a narrow window of time, they were transporting students from school locations that varied in distance from site, where students attending schools on the West side of Portland were over an hour away, while students attending schools in East County were sometimes as close as twenty minutes. Today, the buses had all arrived within 15 minutes of each other, which led to other problems: the nurses office, a small cabin

situated in a stand of firs and hemlocks, with sword ferns, Oregon grape, and salmonberry scattered along the ground, was a hive of chaos.

While the nurse attempts to deliver her message to a squirrely bunch of sixth grade girls, I wait with the group of boys some 20 feet off in the distance, and watch while the student leader attempted to occupy them with a game. Such games were part of the toolkit the program attempted to supply to student leaders, recognizing that the coordination of many bodies spread across the large site often resulted in down time. And as all teachers know, down time is a dangerous seed of mischief, especially when planted amongst a group of sixth graders who are feeling the freedom that accompanies a classroom without walls.

"Alright, let's play a game," the student leader says, and motions the students to form a circle around him. "Watch what I do, and then try to follow my moves exactly." He holds his left hand up in front of him, palm in, and with his right hand's index finger, begins by lightly tapping the pinky finger of his left hand, and says" Johnny, Johnny, Johnny, Johnny, whoops, Johnny, whoops, Johnny, Johnny, Johnny, Johnny." Each "Johnny" corresponds to the right index finger touching each finger on the left hand, from pinky to thumb and back again, with the "whoops" falling as the finger traces the space between the left index finger and thumb at the turn-around point. Not a move that requires much dexterity, and the trick is that after the hand motions and chant, the student leader nonchalantly places both hands together behind his back.

Instantly, a chorus of "Johnny's" erupt as the students fall into attention, and begin to try the game. Seeing that the student leader has successfully prevented the downtime from becoming dangerous, I amble off to see where else I may be of help.

After each group has been to the nurse's station, where they are given a brief lecture on the importance of drinking water and remembering to go poop, they are led to one of the respective cabin areas. Here, an initial orientation of sorts begins.

The Fir Crest cabin area is situated in a large clearing that faces east, and on clear and sunny days like this one, the peak of Mt. Hood hovers off in the distance, beyond the deep gorge that sits between us and the mountain, carved by the path of the Sandy River and the Bull Run reservoir that sits directly below. Six rustic cabins are spread across the clearing, with a seventh building housing a set of toilets and sinks. As I arrive, two of the four classes have already made their way down, and each group's tour guide is attempting to engage them in games similar to the one described above. Such games can only hold the attention of revved up sixth graders for so long, and already students are pulling away from the organized activities, many of them eyeing the strangers from the other school, imbued with an otherness that Outdoor School hopes to diminish as the week progresses.

The other two groups of boys follow close behind me and as they arrive, two of the three male program leaders begin to organize the students into a large circle in the center of the cabin area. The third male program leader is busy with the site supervisor, one of the female program leaders, and the four classroom teachers who are delivering notes about individual student needs, and assisting in the process of forming cabin groups.

As the circle slowly forms, one of the program leaders stands at the center, while the other directs traffic from without, reminding the student leaders to spread themselves out, rather than clumping together out of habit. I join the circle, too, choosing a spot

between a group of students who seem prone to distraction, an almost automatic move to use my proximity as a method of management. The talking among students waxes and wanes for a moment or two, while the program leader in the center stands with his hand in the air. When the site supervisor greeted each class on their buses when they first arrived, one of her messages was about this signal indicating the request of silent attention. The program leader in the center turns around in a slow circle, face placid and calm, hand raised, while students slowly come to attention.

And when the group is mostly quiet: "Thank you gentlemen, and welcome to Fir Crest, your home for the next week. Please look around you, for while you arrived today as four separate classes, this week we will work towards building a community, a task requiring that all of you work together." He pauses for a moment, while students look around this circle of roughly fifty five human beings. "Building a new community is hard work," he continues, "but with it also comes a tremendous opportunity. Each of you has an identity back in school, and whether you came with a class of students you have known since kindergarten, or are relatively new to your school, those identities can be sticky. Good or bad, they can be hard to shrug off. The opportunity I present you with here, and that I invite you to consider during this week, is to begin to think whether that self that you are back at school is the best version of yourself. Here at Outdoor School, you don't yet have a reputation. So think of this as a fresh start. We invite you to experiment with yourself, to throw yourself into new things, new relationships, and to find the ways that each of you can contribute to making the most of this Outdoor School experience. For it comes around only once and you are in part responsible for making your experience here a good one."

Some of the sixth graders stare at the ground, shuffling feet in the loose layer of fir needles and duff. Others continue to carry on whispered side conversations, but this message seems to capture the attention of most. "We have a saying here at Outdoor School," the program leader continues. "That saying is, 'Things worth doing are hard.' And I recognize that we will be asking a lot of you during this week. We will ask you to try many new things, and some of these things you will like a lot, and others not so much. But all of these new things are part of this larger opportunity to develop the community that you want to be a part of, and to find the role that you can play in making this community one that works for us all. So we're going to practice saying this phrase, and we will say it frequently throughout the week, as a reminder of the important work that we are doing, and it is because this work is so challenging that the reward it promises is so big.

"Like all things, saying and meaning this takes practice, so lets do some practice now. On the count of three, I want all of you to say 'things worth doing are hard' together, as a community. Ready? One, two, three…"

On this first attempt, approximately half of the students attempt to mumble these words along with the program leaders and the student leaders, whose loud voices mostly muffle the sixth graders. I watch as the sixth graders watch one another. Is the shouting of such a strange phrase going to be socially acceptable? As the sound from the first attempted chant dies down, a strange silence settles temporarily over the group. Now, most eyes are firmly on the program leader in the center.

"Alright, that was a pretty good first try. I can tell that some of you are still warming up. Here's the thing: I want the rest of your classes, who are currently clear across the other side of camp from us, to hear our words, and know we mean them!" This challenge seems to inspire some sixth graders, who more firmly plant their feet, and take deep breaths, anticipating another go. "Lets try this again. One, two, three…"

This time, the words are more in sync, and the participation seems to have spread. "Better, that was much better! And we will continue to get better as we grow and strengthen our bonds as a community. One, two, three..."

THINGS WORTH DOING ARE HARD!!

"Alright, I am starting to believe you! Now, please stay with the student leader who brought you down here, and begin to make your way back up towards the dining hall, where we will provide a brief orientation, and allow the rest of the staff to introduce themselves before the moment many of you have been waiting for, when you will find out which cabin you are staying in. Let's go!"

The brief spell of cohesion begins to break, as the sixth graders swarm around a student leader, comfortable in their class groups once again, and begin to walk up the slowly undulating path that leads back towards the center of the camp, situated around a big field, and framed on either side by a large building that is the dining hall, and on the other, a building referred to as Tilamook, which serves as a chapel during the Catholic summer camps that also occur in this space. In this intentionally secular space, the chapel houses animal field study, and provides a location for evening campfire when the weather prevents us from being outside. As I follow the swarm of sixth grade boys as we emerge alongside Tilamook and begin making our way towards the dining hall, I can see

the other half of the sixth graders spill down the hill from the Alder Grove cabins, situated up a hill between the dining hall and the nurse's station.

Large logs lie horizontally in tiers in front of the dining hall and the four field instructors are waiting for us there, where they help the classes of sixth graders find a place to sit, and encourage the student leaders to disperse themselves among them, again taking advantage of the management through proximity approach. As the groups settle, the site supervisor, along with two of the program leaders and the four classroom teachers, appear too, meaning its time for the show to begin.

This also marks the first time that all of this week's residents are assembled together in one place. Recognizing how hard it is to ask the collective body of sixth grade students to sit quietly for very long, staff try their hardest to move through these introductions as quickly as possible. The site supervisor begins by welcoming everyone, and tempts them with the fact that as soon as introductions are complete, they will finally be able to move into a cabin and then return to the dining hall for dinner.

She also gives the first of a series of speeches on the topic of comfort, and this idea more peculiar to Outdoor School, that "everyone's got their thing." "Welcome to Outdoor School! I am so glad you are all here to share this week with us, and I hope you enjoyed your brief tour of the site. I want you to all take a moment and look around. You are sitting with the four classes you came here with, and this class will always be special, because you will share in the memories of the week to come with them for the rest of your life. Importantly, you are also sitting near a lot of new faces, of people you don't yet know, and who don't yet know you. And we are going to ask all of you this week to work together to build a community. Building a community is a difficult thing,

especially when we ask this work to be done over the course of a single week. But we wouldn't ask this of you if we didn't know that it is possible, that in fact it happens every week at Outdoor School, though always in unique ways that depend on all of you.

While not knowing three quarters of the people around you may seem like a big challenge when it comes to building a community, I want you to also see it as an opportunity. Sometimes at school we can feel stuck. I know that some of you may have been in school with the same group of people since you were in kindergarten, and it can be really helpful in new settings like this one to have some people around that you know. At the same time, we sometimes develop reputations and identities that we might grow tired of, and that are hard to move away from when that reputation is the only version of yourself that your classmates and teacher have come to know and expect.

"Here at Outdoor School, as you may have already heard, we encourage you to experiment with that person that you are at school, and to ask yourself, who is the person that you want to be out here during this week? This is a big task to add to a week already full of meeting new people, exploring new ideas, and learning new ways of interacting with the world around you. And in order to make all of this possible, we want you to know that the comfort of every one of you is extremely important to us. Take a look around you again, and notice all the people wearing these red jackets. These are the permanent staff members here, and they will introduce themselves here soon. In addition to the different roles that staff play here, they are all also concerned with each and every one of you, and in your comfort and success. The tricky thing about comfort is that it looks and feels different to all of us, and sometimes we have learned to be really good at hiding our discomfort, of pushing it down towards our toes, and ignoring it.

"There will certainly be moments this week when we ask you to try new things, and these things can seem scary. What we promise, in return, is to also work towards making sure that each of you are comfortable while trying these new things, and we need your help with this. Because comfort is different for us all, we don't always know what it is that may be making you feel uncomfortable here, and so we ask that whenever you are feeling unsure, and unsafe, that you find one of these staff members and tell them what you need. That is the promise that I want to make all of you right now, and it's a promise that I need all of your help to make true.

On the one hand, community building is about coming together. But this coming together doesn't have to come at the expense of any of you losing the things that you need to feel cared for, and ready to leap into the many challenges that will come your way during this week."

She nods at one of the male program leaders, who joins her at the front of the logs. He begins: "We have also introduced you to some of the sayings we have here at Outdoor School, and I want to share one more with you. That saying is, 'Everyone's got their thing.' It's a simple saying that we think is really helpful when building communities. It about how we all have differences, some of which may make us feel embarrassed. One of my things, that I used to really worry about, is that I am a mouth breather." He pauses for a moment to demonstrate, and a brief ripple of laughter rolls across the sixth graders, who appear not entirely sure whether this is something that can or should be laughed about. "And yeah, it is kind of funny. And I used to not notice it. It's not something I think about, and I do it especially when I am nervous. The first time someone pointed it out, I got really embarrassed, and started to think about it all the time.

So at school, and when I was hanging out with friends, I would spend all of my mental energy thinking about mouth breathing. And it was exhausting.

"All of us, we have these things that make us different, unique, and special, and sometimes its hard to know how to share these pieces of ourselves. But not sharing them can be just as hard. So here at Outdoor School, we encourage you to share with one another the things that make you special— both those that make you proud, and also those that make you scared and uncertain. And if you remember that everyone's got their thing, it can make that sharing easier."

Next, groups are introduced one at a time, beginning with the four classroom teachers, then the student leaders, the field instructors, and finally the program leaders. I introduce myself with the four field instructors, referring to myself as the field instructor in charge of research, and that my job is to observe the ways in which the four different field studies, and the rest of the Outdoor School program, work together.

Once the program leaders have introduced themselves, the group of sixth graders is once again divided by cabin areas, where students huddle in wait for student leaders to read off the names of the sixth graders who will join them in their cabins. As this shuffling is happening, with sixth grade boys heading off to circle up around their student leaders and the sixth grade girls staying where they are, I'm left standing in the middle, doing some shuffling of my own. I feel a light tug on the hem of my red wool jacket, that, along with the introductions, marks me as part of the staff. I look down, and see two boys standing in front of me. They look uncertain of themselves now that they have my attention.

"Yes?" I ask, crouching down to lessen the distance, the popping of my knees as I squat eliciting a brief giggle from the three of us. "Ummm, you know how the lady just told us to come tell some one in red if there is something we need to feel comfortable?"

"Yes, of course," I say. "What can I do for you?"

"Well, you see, my friend and I here, we have this thing, something that we need to feel comfortable here…" His eyes haven't left the ground since he started this sentence, and he now looks briefly to his friend for help, but he just shrugs and turns slightly away from me. I wait, rocking back and forth on the balls of my feet. "In our families," he continues, "its really important that we pray five times a day." His eyes dart to meet mine for a moment, judging my response. "Do you think that is something we can do here?"

I smiled. "Yes," I said. "We can definitely figure this out." And so we did.

CHAPTER VI

FIELD STUDY STORIES, PART I

Monday morning. Students have finished their second meal together in the dining hall, where the boisterous energy that marked Sunday dinner has become something different. The experiences of this new place, of sleeping in cabins with strangers, and the new array of noises and smells—the squeakiness of sleeping bags sliding across mattresses with their plastic coverings, the mix of duff and fir needles and fungus and pine sol, that unmistakable odor of cafeterias—have slowly begun to settle onto the residents, to mix with their minds, to shift from the surreal dream of Sunday's arrival, into something decidedly more serious. And so a certain heaviness accompanies the eating of breakfast, as the one hundred and twenty sixth graders work to bridge the gulf between their expectations of this adventure they have heard so much about, and the reality of it unfolding in front of them.

At the end of breakfast, students finally learn the final mystery surrounding the signs and symbols that adorn their wood cookies: each is marked with a letter, A-D, and these letters will sort students into four different groups, mixing them with new peers from the three other middle schools, who will accompany them on the adventures in learning that are about to begin.

Outdoor School is organized around four field studies. But in the fall, I learned that a fifth field study emerges all on it's own. As the rains begin, a strange transformation takes place across the forest. The dense networks of mycelium, as invisible as they are ubiquitous, begin to show themselves as innumerous mushrooms lift

up the duff, their slimy heads, seemingly far too delicate for such an act, demand to be recognized.

As anyone who has gathered edible fungus before knows, there is this strange moment before you see the first mushroom when they remain completely invisible, our eyes not yet trained to notice them. And then, after that first elating moment of surprise when you notice that the small patches of orange, cream, blue, and gold that your brain has made continuous and undifferentiated from this thing we mistakenly label as ground, as if it is some uniform whole, are in fact the caps of many organisms, inviting us to take notice, to wonder, to experience the awe and strangeness of life.

That the mushrooms emerge from the ground is hardly an accident. Their stalks, caps, gills, and spores all serve a purpose, and a purpose that could not be served were they to remain underground. Like flowers' relationship to plants, the mushroom is the reproductive unit of fungi, intentionally showy, both in order to attract eaters, and to warn them of their poison. "Notice me!" they seem to shout to the careful observer who has learned their wily ways. This learning to notice, to take into account, is one of the central tenants of the science that is taught at Outdoor School.

Plants

As students jostle in through the doors of the "plant palace," as the building is affectionately known, to escape the rain, and arrange themselves on angled benches, some of them notice a strange three word question written on the white board situated at the center of this space: "PLANTS ARE ANIMALS?!" Some of them scoff at the childish nature of such a question. Others seem to consider it with a bit more

engagement, and as the plant field instructor encourages them to finish finding a seat, he gives them an often heard Outdoor School reminder: "If you have chosen to sit next to people with whom you have a hard time making good choices, I invite you to move to a better location now." This invitation almost always brings with it a moment of quiet contemplation, as students wonder at the agency they have just been invited to enjoy.

"Welcome to plants field study," he says. "We are going to begin our journey today with a question, a question that might seem silly at first. But it is a question that scientists have wrestled with throughout history, and a question that they continue to wrestle with today. And while the answers they pose to this question are many, we are going to focus on two possibilities." He grabs a white board marker, and below and to the left of the question he writes, "Totally true!" and to the left, "No way!"

"We all know that scientists like to do experiments, and we often imagine them in white lab coats, with beakers and chemicals and Bunsen burners and the like. By scientists also like to argue, to debate, and to hypothesize. Does anyone know what that means?"

A number of hands shoot up, and from the back, someone shouts, "It's a guess!"

"I know this is exciting stuff," the plant field instructor continues, "and I ask that we raise our hands so that everyone can hear the important ideas you have to offer." He motions towards a student who remains sitting quietly, her arm patiently stick straight, hand slowly turning side to side. "Do you want to add anything?"

She takes a deep breath: "A hypothesis is like an educated guess that scientists make about an experiment, and then they see if what they find makes the hypothesis true or not."

"Alright," the plant field instructor says, "that is some good additional information. And while we are not going to do an experiment just yet, you all have had plenty of time over the course of your lives to make observations about the world around you, to collect evidence that might enable you to answer this question in a variety of ways, and I invite you now to talk with the people around you. You can choose one of these two answers, and think about all the things that make it true. Or you can think about both at the same time, and make a list of the ideas that support both. Go!"

Students turn to each other, and begin to discuss, many of them highly animated, gesturing wildly. In one corner, three students are puzzling over whether or not plants have brains. Elsewhere, a student is contesting the idea that plants don't move. And then I look towards the back of the room, where one of the classroom teachers is standing, watching, and doing a poor job of hiding his discontent.

After several minutes of engaged discussion, the plant field instructor focuses the group back towards the front, and asks for volunteers to share ideas that support either of the two claims. Hands shoot up again, and students begin to share their thinking. When one student suggested that one reason plants and animals are different is that animals hunt food, another student brought up carnivorous plants as a seeming counter example, and another talked about animals like mussels that are filter feeders, an equally passive-seeming mode of gathering food. The topic of movement came up too, and students debated whether or not plants move in the same way that animals do, where students talked about ideas ranging from phototropism to seed dispersal. And the question of plant brains was also a topic of much debate. One young lady asked: "If plants don't

have brains, then how do some of them know when to drop their leaves in the fall?" which elicited a deep and profound silence from the group.

Students also talked about cellular differences and similarities. To some, the fact that both plants and animals had cells was evidence of their similarity, while others pointed out that plant and animal cells are different. In a similar vein, students talked about the similarity in terms of what animals and plants require for life, as well as the differences. One student said that both need water, and some type of food. Another pointed out that plants make their own food, and some one else added that this didn't take away from idea of food as requirement. Once again there was a moment of silence, of eyes on the plant field instructor. A hand lifted slowly, and with a nod from the field instructor, a soft voice said: "But plants can do photosynthesis, and animals definitely can not!"

I glanced back at the classroom teacher and saw a look of triumph in his eyes. I think he even did a little fist pump. "I'm so glad you brought that up!" the field instructor replied, "And I want to spend a moment talking about photosynthesis." He draws a simple plant on the board, stem, leaves, flower, and roots, and guides the students through a pictographic description of photosynthesis, showing them that all the necessary ingredients for this miraculous process could be found in the plant's environment, and emphasizing the important role that plants made in converting solar energy into a form that both plants and animals and fungi could use.

He continued: "For a long time, this ability to photosynthesize has been a pretty amazing way to decide whether a creature is a plant or not. But the cool thing about science, to me anyway, is that nature keeps throwing us curveballs. Just when we think

things are settled, we come across some new bit of evidence that makes us sit back and say, 'huh?' And I have recently been absolutely obsessed with just such a new piece of evidence, a strange creature that I want to share with you all today. This creature is called a solar sea slug, and I've got some pictures right here to pass around."

He begins to hand out several laminated copies of an image of something that looks like a crinkly green leaf of sorts, where the end that looks like it should attach to the rest of a plant instead possesses a pair of small antennae. "These slugs," he continues, "are related to the ones you might see out in the forest today, except that they live in the shallow waters off the East Coast. These slugs feed primarily on algae, simple plants that live in the water. Recently, scientists have discovered that these slugs appear to save the chloroplasts, or the parts of plant cells that allow them to photosynthesize. It may even be that the slugs are stealing the genes from the algae, and are now able to make their own photosynthesis factories. So, if we decided before that plants are plants because they have the ability to photosynthesize, what do we do with these solar powered sea slugs? Are they animals? Are they plants? Or maybe we should start talking about a new group of organisms…"

"Planimals!" someone shouts from the back, and the group breaks into laughter.

"Yes," the field instructor says. "Maybe in the future, Outdoor School will have to think about adding a new field study. And in the meantime, I encourage you to carry this curiosity with you as you head out to learn about the plants and fungus that can be found in our forests. How does thinking about photosynthesis help us understand what plants need to survive and reproduce? How do they help us think about the adaptations

that plants have? In a moment, one of our fearless plant student leaders will call out some names, and you will join them on this journey of exploration and discovery!"

The student leaders come up front and read off the names of the students who will join them for a several hour hike through the forest, where they will learn how to describe and characterize leaf shapes, to name some of the plants most common to the area, and to look for patterns that help think about the complex ways that plants have adapted to the particular conditions of forests in the Pacific Northwest. As the students gather in small groups, introduce themselves, and begin to head out the door, the teacher who has been observing begins to make his way towards the field instructor, who is gathering together pictures of the solar sea slugs and erasing the white board.

"Interesting lesson," the teacher announces.

"Thanks," replies the field instructor. "Thanks for joining us.

"That was my student who brought up photosynthesis, by the way. I have been working really hard with them this fall to understand the differences between animal and plant cells. And I have to say, I am kind of worried that your lesson here just made a confusing mess of what I have been trying so hard to make clear to them."

The field instructor pauses his activities, straightens up, and turns his attention more fully towards this teacher. "Well, I am sorry that you feel that way. It certainly wasn't my attention to confuse anyone."

"But you did! Couldn't you see that?"

"They looked interested to me. Not confused."

"Well, I know my students much better than you do, and they were definitely confused." His voice continued to rise in both pitch and volume. "I am going to have to

do a lot of correcting back in school on Monday. It is very possible that a question about plant and animal differences may come up on a state-wide exam. Do you think the test cares whether the students are interested or not? And I hope you think about that before you give this little lesson of yours again tomorrow."

The field instructor looked at one of the pictures of the solar powered sea slugs for a moment. "When I was in middle school," he began, "I was bored all the time, and got in trouble a lot. And I think that a lot of students feel the same way about school. When I was doing some reading this past summer, I came across this article about these little sea slugs, and I thought, this is what I would have wanted to learn about when I was in middle school science. I think it connects them to the wonders of science, the part of science that I love, and the part I never really got a chance to explore in school. And, I think this is a great way to get students to do some deep thinking."

"These are sixth graders we are talking about! Maybe you have forgotten that students at this age need concrete explanations, they need to understand the rules, not worry about the exceptions."

He shrugged. "Maybe they need both. And, if you don't mind, there is some exciting learning going on out there right now, and I don't want to miss it."

Student Leader: For me, the science learning is kind of like the backdrop to what I really think the foundation of ODS is, which is showing kids alternative learning, showing them that there isn't just one way to learn. That is something I say before every field study with all my groups. I remind them that this is a totally unique experience that they aren't going to have all the time, and that learning

isn't just something that takes place in a classroom, that it also takes place outdoors. It's not something where someone is going to be someone talking at you, but where you can participate and ask as many questions as you want. There is not a test. The learning is fun, there is no need for tests. So the science is showing kids that learning is multifaceted, large concepts, not just this narrow learning-taking tests cycle. It's actually a very large thing.

The trail that forms the curriculum of plants field studies can be experienced in multiple ways. Once you know the twists and turns, and the relationship between the forks and sidepaths, and the way it meanders in circles through groves and over streams, you realize that the entire thing can be easily hiked in twenty minutes or so. However, the student leaders have been taught to slow down, to pause often to encourage students to touch, feel, smell, and engage with the plants and trees endemic to forests that fill the foothills of the Cascades. And because the sword ferns and vine maples and hazelnut trees and salmonberry are so dense, and the tall Douglas Firs competing for the open sky so nearly complete at blocking out the light, there is a feeling of having slipped quickly from the domesticated grounds of a summer camp and into some primordial wilderness.

Along the hike, these competing forces of domestication and wildness play off each other in interesting ways. On the one hand, students are invited to venerate this land and all its fecundity, to experience its ability to dwarf us, to remind us our relations to a land that we interact with but do not control. And yet, in doing so there is always the danger of exotifying, of reifying this romantic conception of nature as ineffable and an

extension of the adage that stewardship requires both knowledge of and love for our surroundings

I wander up to a group of five sixth graders, standing in a loose half circle around their student leader. Standing back and to the side a bit, another adult is also observing. She is a former student leader, currently in college, and is spending the week as a special needs volunteer. These individuals are paired with students who can require additional support during field study, students who carry with them diagnoses ranging from autism to oppositional defiant disorder. Volunteers are encouraged to interact with groups of students so that their attachment to one individual is not glaringly obvious. The ease with which this task can be accomplished varies from student to student, and volunteer to volunteer, but the presence of additional adults hanging around on the edges of groups is fairly commonplace. Classroom teachers, field instructors, and program leaders all tend to roam during field study, observing and occasionally supporting the student leaders in their efforts to keep groups engaged, making my presence somewhat less obtrusive than it might have been otherwise.

The student leader reviews the terms evergreen and deciduous with students, and informs them that there are two different species of evergreen trees that surround them. "What I would like you to do now," she says, "is spread out, examine the evergreen trees here, and see if you can notices some of the differences between these two different types of trees."

"What do you mean? Like that some are taller than others"

"That is a good point," she responds. "What do you think makes some trees so much taller than others?"

"Different kinds of trees?" the student offers.

"Yes, that could be part of it. But you are all different heights, and I am taller than all of you!" she laughs. "Do these differences mean that we are different kinds of animals?"

"No! Its just because everyone is different!"

"And you are much older than us!"

The student leader laughs again. "Yep, that is true. Trees can certainly look different and still be the same species. Just like us, each individual is unique. So what I am asking you to do is to look for some patterns. I want you to do some exploring, and tell me what you notice about the trees that are growing around us. Spend a couple of minutes being careful observers and then we will come back and see what we see."

Students are a bit hesitant at first, and remain standing on the trail, looking around them at the myriad of trees.

"Its okay to walk off the trail as long as you are respectful of smaller plants growing around us. And remember to touch and smell things too. Just remember that we are going to leave our sense of taste for the dining hall only! If you find parts of these trees lying on the ground, you are welcome to collect some as evidence."

Students begin to wander away, in a pair and a loose group of three. The pair are drawn towards a large evergreen, and they stand at its base, staring up its straight trunk, feeling its thick bark, and finding out that if the two of them stand across from each other on opposite sides, they can just barely join their hands around the girth of the tree. The group of three scours the ground for evidence, handling cones and examining small twigs that have fallen to the ground. The student leader encourages them to make a pile of

interesting finds on the edge of the trail, and as students' attention begins to wane, she calls them back together.

"So what did you notice?" she asks.

"They smell good!" one student exclaims, holding up some needles to her nose. "And that tree over there is covered with sap and I got some on my hands!"

"Yeah, and we also noticed that some of the trees are tall and skinny, and others are tall and fat. We could just barely wrap our arms around the trunk of the one over there."

"Good!" the student leader encourages. "I also saw you two feeling the bark of that big tree. What did you notice?"

"That the bark was really thick and rough. It kind of looks like puzzle pieces."

"Great observation! Do the puzzle pieces fit together smoothly, or are there spaces in between?"

"Spaces!" two of them chime together in unison.

"Yes, lets all head over to that tree and take a closer look at this bark." They wander over together, and soon five sets of hands probe the bark. "We say that this tree is the 'grooviest' member of the forest, because its bark forms this pattern that, as you mentioned, looks a bit like puzzle pieces with these deep grooves in between. You two also mentioned other trees that were skinnier. Can you lead us over to one of those?"

One of the sixth grader points some fifteen feet away, and goes bounding off towards a tree that is decidedly skinnier. The rest of the group follow, and take turns feeling the bark. "This one is smoother," one of them offers.

"Yep, no grooves here!" another says, grinning.

"What else do you notice about these two trees?" the student leader asks. "Take a look at their branches, and the way that they grow." The students pause for a moment, and take another look around them.

"The skinny trees have branches all the way up, and it looks like all of the lower branches on the bigger ones broke off somehow, and now all that's left are the branches near the top. Did someone cut them off, like for firewood or something?"

"That is an excellent observation!" the student leader offers. "And no, I can tell you that the branches fell off without any help from humans. Can anyone imagine why that might happen?"

"Maybe they got too heavy and broke off in a storm?"

"Or maybe the tree just didn't need them anymore?"

"You are both on the right track, and I actually don't know what causes the branches to finally break off. I want you to think back to what you talked about this morning, that special process that makes plants different from animals, and that also requires a special green pigment that gives leaves and needles their color."

"Chlorophyll!"

"Yes, that is the special green pigment. Does anyone remember the name of the process?"

"Photo…"

"…Synthesis. Photosynthesis! That is when plants make energy using the sun!"

"Yes, good team work," she nods, grinning. "Now, why might a tree no longer care for the branches that sit further down?"

"Well, because there's not much light down low, because the higher branches block it out."

"But how do they know when to drop their branches? Does it hurt the tree?"

The student leader pauses for a moment, and her eyes meet mine with a questioning look. I shrug my shoulders.

"Those are really interesting questions, and I admit that I am really not sure about the answer to either."

And I can't help but add: "It may be that scientists are right now busy investigating similar questions, and sometimes science benefits just as much from good questions as it does answers!"

This elicits a slight pause from the group, until the student leader continues: "While I don't pretend to understand how it works, this behavior, which scientists call 'self-pruning,' is an important adaptation for these trees, and it also makes it pretty easy to recognize them when they are growing in forests like this. This tree is called the Douglas Fir, and you may have heard that name before, because this is our State tree, the one you see on license plates. Douglas Firs are shade intolerant, which means that they really like the sun. As so as one of you suggested, these trees put all their energy into maintaining the branches that get plenty of sun, and they grow quickly upward, competing with one another and other trees in the forest for light."

"But the skinnier trees have branches growing all over the place," and the student wanders over and puts his hand up to touch a low-hanging branch from a tree growing just off the path, running his hands along the needles."

"Yes! And that tree you are touching now is a Western Hemlock. Hemlocks are shade tolerant, meaning that they don't mind growing in shady conditions. Hemlocks tend to be slower growing then the sun-loving Douglas Firs. But it's a bit like the story of the Tortoise and the Hare: these Hemlocks continue growing in their slow and steady way, and eventually they may reach up above the canopies of the Douglas Firs."

"And then what happens?"

"Well, since the Douglas Firs are shade intolerant, I suppose they don't do very well once the Hemlocks grow above them."

"Then how are there any Douglas Firs around at all?"

The student leader smiles. "Remember that thick and groovy bark we looked at a moment ago? Well, that bark provides great protection to the Douglas Fir, and means that Douglas Firs often survive forest fires that wipe out the Hemlocks. And now that you have been introduced to these two types of trees, lets check out the cones and needles that some of you gathered before, and take a closer look at some of the other differences between these evergreen trees."

The students crouch around in a loose circle, dissecting cones, examining the arrangement of needles around twigs, and listen while the student leader tells them an indigenous story about how the Hemlock came to have such tiny little cones, and needles of all different sizes, and how the Hemlock, out of embarrassment, tends to have a droopy top, a head hanging in shame. After this talk of trees, the student leader begins to introduce the students to some vocabulary words that help to describe different shapes and arrangements of leaves of deciduous plants. She makes a point of telling them that she is far from an expert on naming the many species of plants that make up the dense

undergrowth of these forests, emphasizing instead the ability to use this vocabulary to carefully communicate the differences that students observe when comparing leaves from one plant to the next. As I walk away from this group, I smile to myself, realizing that I am not sure which of these five students was deemed in need of additional adult support.

Student leader: One of the things I have found pretty consistently is that before we teach we get kid notes that teachers send out, and almost every time, we hear that there are certain students who are going to act out, or don't do so well, and I never have problems with those kids, once you get out there everyone is so excited to learn because they aren't in that standard 'sit in a chair for seven hours', you are up and moving and doing things… I think that is really cool, because I don't see that much at my school [laughter]. There is not a lot of love of learning happening in second semester of senior year [Laughter]! It's really cool to come out here and have both student leaders and 6th graders that are so passionate about what they are doing.

Animals

Student leader: One of my favorite things about animals is that people often forget that we are also animals, and when I teach about a skull, I tell students to feel around their own mouths, and the thought that we are also animals living on this earth… once they make that connection, that humans are animals also at the mercy of the world, it's a humbling experience.

Tuesday morning. The rain continues, and small rivulets run down the main trail as I trudge up towards Tillamook, the site of the first half of animals field study. Where plants begins with a hike in the morning, and then engages stations in the afternoon that involve learning about flower parts and pollination, tree parts, and logging practices, animals begins with stations. Studying plants in the field is a relatively easy task—they wait patiently for our approach, inviting us to ponder and examine them in all their rootedness. Animals make no such promises. Careful study and observation requires a different approach.

I enter Tillamook, a cavernous building that seems to resist the warming efforts of the lone heater mounted high up on one wall. But at least it's dry, and I shake off my rain coat and hang it up as I take stock of the six groups spread out around the room. For the most part, groups are huddled around large Tupperware bins, the contents of which are being slowly assembled on the floor, or passed around from person to person. These bins are the result of incredible curation efforts performed by the animals field instructor, who has been filling this position for over ten years. Each is organized around a topic, like birds of prey, horns and antlers, pelts and skulls, arthropods, and canines and mustelids, and as the contents emerge, so does the feeling of having entered a carefully constructed museum exhibit. Although unlike most museum exhibits, this one encourages touching.

While the content of most of these bins is decidedly dead there are a few exceptions, and I wander over to one corner, permanent home to the reptiles and amphibians exhibit, where six silent sixth graders sit in folding chairs, their attention fixed firmly on the student leader. In fact, it is not really the student leader who has their attention, but rather the small dark colored snake he is holding. The back half of the

snake is curled loosely around his arm, while the head moves cautiously in space, appearing to defy gravity, tongue flicking to sample whatever chemical signals are being carried on the currents of air.

"This is McGonagall, and she is a rubber boa. Rubber boas are native to this area but they are very secretive and hard to spot in the wild."

"It is poisonous?" one of the students asks, a faint look of terror in his eyes.

"No, she is a constrictor, which means that instead of relying on venom, she kills her prey by wrapping her muscular body around them. And every time the prey—like a mouse or something—exhales, she tightens her grip a little more, and eventually the animal suffocates."

"Cool! Then what?" asks another student, who can barely stay in her seat from excitement.

"Well, then McGonagall swallows the prey whole!"

This elicits a chorus of "Ooohs" and "Yucks" and "Awesomes." Even the students who look most terrified can't peel their eyes away.

"In fact, we got to watch McGonagall eat a mouse on Sunday before you arrived, and if you look carefully—you see that bulge here? Well, that is the mouse working its way down the snake's digestive system. I am going to keep a hold of McGonagall, but if you'd like, you can touch her. It's important to be gentle, and because of her scales, you need to stroke her from her head towards her tail."

Two students lean forward in their chairs, and tentatively reach out fingers and run them along the snake's dark olive scales.

"Its so smooth! It looks kinda slimy, but it's not!"

Eventually, all but one student takes a turn at touching the snake. "Scales are a trait that all reptiles share," the student leader continues. "Can anyone think of any other kinds of animals that are also reptiles?"

"Lizards!"

"Good. What else?"

There is a momentary pause.

"Crocodiles? Alligators? I mean, they both have scales…"

"Yep," the student leader says, looking over an information card on reptiles he holds in his hand. "So, thinking about snakes and lizards and crocodiles and alligators, what are some other things that all reptiles have in common?"

"They all have teeth!"

Another pause. The student leader shoots me a questioning look. And I too think for a moment. "Well, I can think of at least one group of reptiles, one that you all haven't touched on yet, that doesn't have teeth."

"Is it something really weird that no one has ever heard of?" a sixth grader asks.

I laugh. "No, I'm pretty sure you all know animals in this group. In fact, there is a picture of one on the wall over there." I point towards a poster on the wall with a Galapagos tortoise who appears to be smiling. Definitely no teeth.

"Turtles?!" a student exclaims. "But aren't they amphibians? I mean, they definitely live in both water and land. Isn't that what amphibian means? Like I watched this show one time about amphibious vehicles that can go on both land and water."

The student leader perks up. This is a topic student leaders on animal field studies have practiced explaining, and one that is covered on his information card. "This is kind

of tricky, because you are right—the word amphibious does relate to the ability to be on both land and water. But the word 'amphibian' describes a particular group of animals, just like 'reptile' does. So you can be amphibious without being an amphibian, I guess you can say."

"But why?"

"Let's come back to my earlier question, about the things that reptiles have in common. We talked about their scales, which turtles have, and is part of what places them in the reptile group. And I don't know if you noticed the animals in this tank over here…" Students shift their attention over to a small fish tank sitting next to the snake cage, filled with five centimeters of water, and with rocks and twigs and leaves piled up on one end to create. Several small creatures float in the portion with the water, and on the land side, a larger dark brown animal sits silently on a bed of moss.

"Newts!" a student says. "We saw them yesterday in the pond during water field study! I was a boss at catching them with a net. I even caught two at a time! I think they were having sex!"

Some students join her in laughter, while several others look somewhat nervously to me, testing whether or not such language is appropriate in this setting, and then a look of relief when the student leader and I also both chuckle. "Okay, so what do you notice about these newts? They are classified as amphibians. How are they different from reptiles?"

"That's kind of weird," a student notes, "because they look a lot like lizards to me."

The student leader slides the top off the tank, and motions students over. "If you are really gentle, you can reach in and feel the skin of this newt here. Tell me what it feels like."

"But isn't their skin poisonous?" a student asks.

"Yeah, but we will wash our hands before lunch. So just don't lick your fingers if you are going to touch the newt!"

Several students take turns tentatively reaching their hands down into the tank, and lightly brushing their fingers along the newts back.

"Its bumpy" one offers, "and feels kinda moist."

"Eww, I hate that word! Definitely not touching that thing now."

"These critters are called rough skinned newts, so yeah, the skin does feel bumpy. And they really like wet environments, and as you all saw yesterday, spend a fair amount of time in the water."

"And are those its babies?" a student asks, pointing to the smaller ones floating in the water.

"Not sure if the babies belong to this adult, but yeah, those are young rough skin newts. And before we talk about those, do you think that rough skin newts have scales?"

"No…but I'm not really sure what they do have."

"You are right about them lacking scales, and that is part of why, even though as one of you pointed out, these newts do look a bit like lizards, there are also some important differences. What else do you notice about the young newts?"

"Some of them have arms but no legs! Did something eat them?"

"Nope! One of the things that make reptiles different from amphibians is their life cycle. Baby reptiles tend to look just like adults, only smaller. But as you can see here with these newts, the babies look very different from the adult. What other differences do you see?"

"Well, the babies have these weird stringy things coming off their heads. We saw some of these in the pond yesterday, too, and my student leader told me that those things are gills."

"Great, that is right. What do gills do?"

"They let the animal breathe underwater!"

"Yes indeed! Can you see any gills on the adult?" The students shake their head.

"So what's going on there?"

"It's like tadpoles and frogs, right? One summer, we caught tadpoles in a lake, and later on, we brought them home, and watched them turn into frogs!"

"Nice! Yeah, that is a great connection. Frogs are amphibians too. So why would we find gills on tadpoles and young newts, but not on adults?"

You could almost see the connections and ideas forming and breaking apart as students pondered this for a moment. "I get that the young amphibians live in the water, and need gills to breathe, but we saw the adults in the water, too. Why would they want to loose their gills then? And how do they breathe underwater?"

"Yesterday we watched the newts in the pond for a while, and they definitely came up to the surface once in a while to get a breath."

"Yeah, but it still doesn't make any sense that you would want to get rid of your gills. I would want to keep mine!"

"Ha, you are all really thoughtful, those are some really interesting things to think about. I'm not sure that loosing gills is really a choice, but another really amazing adaptation that newts have is the ability to get oxygen through their skin, which works both on land and in water!" Students seem to instinctively stare at their own skin. "And talking more about life cycles, reptiles and amphibians lay very different types of eggs. Amphibians always lay their eggs in the water, since tadpoles begin their life with gills. Reptile eggs are laid on land. I have some pictures here for you to look at."

He passes around a couple of images of frog eggs—large blobby looking things sitting on the edge of a pond—and turtle eggs, which look a little more like chicken eggs. "What about McGonagall? What do her eggs look like?" a student asks.

A smile spreads across the student leader's face. "I knew someone was going to ask about that. And here is another interesting thing about rubber boas: they actually give birth to live young!"

"What!? Like mammals?"

"Well, not really like mammals, no. I think that snakes like rubber boas just hold onto the eggs in their bodies, but I'm not really sure exactly how it works."

"Nature is weird!" one of the student offers.

"Sure is! And now, who wants to go hold a millipede?"

In the afternoon, animals field study heads outside, where even if live animals choose not make themselves available, students are encouraged to imagine how different worlds emerge when focusing on the needs and habits of animals other than humans. The animals trail makes a big loop around a low hill sitting across the Bull Run Reservoir

from Mount Hood. From a large field above the Alder Grove cabin area, the trail splits: to the right the trail follows an old logging road, where off in the distance the peak of the mountain sometimes shows itself, while the view is quickly obscured by dense undergrowth that fades into Hemlock and Douglas Fir; to the left, the trail narrows and disappears into the Forest.

I make my way up the right side of the trail, and follow the sound of voices to a small clearing to the side of the trail closest to the mountain, where the animals field instructor is speaking with a small group of students huddled around a stump. As I approach, I see the body of a varied thrush, a medium sized bird, laying in profile, the dark grey and orange of its feathers looking freshly preened, and only the two twig like legs poking out at odd angles mark the animal as dead. The sixth grade students stand as if glued to the ground, their eyes intently staring at the bird, which, I begin to notice, isn't entirely as still as a dead bird should be. My attention shifts to a steady stream of ants coming and going from underneath the bird's shoulder, and my arrival has been well timed: the field instructor grasps a stick from the ground, and uses it to gently roll the body of the bird over.

The feathers on this side of the body have no sheen, and both the grey and orange regions have taken on the color of wet newspaper. And though the bird is definitely dead, its body is teaming with life: at least two different sizes of maggots wriggle and crawl on the surface, which in turn are occasionally plucked from their feasting by the army of ants, and carried away back down the side of the stump. Several sharp inhalations of breath sound around me, but not a single student looks away.

"H-how did the bird get here?"

"I found the body lying on the trail yesterday afternoon, and placed it up on this stump in anticipation of this very moment!" the field instructor responds with excitement. "I didn't know to expect the ants!"

"What are those white things?"

"Those are usually called maggots, and are actually the larva of flies or some related insect. Adult flies will lay their eggs near dead animals, and that way, when the babies hatch, they have instant access to a meal!"

"They are eating the bird!?

"Yep! And see the ants? They are taking advantage of an easy meal too."

The students look up at the field instructor, probing for signs that she is joking. Her face is jovial and serious. "It's hard to talk about living things and not talk about death. And there is so much of both going on around us all the time! All of this action here is speeding up the cycling of matter. You may have talked about decomposers earlier when you saw the millipedes."

"Yeah, we learned that they eat dead leaves and poop out soil!"

"So tell me what you all think is going on here."

"Well, the wormy things are eating the dead bird, and the ants are eating the wormy

things, and I guess both will poop at some point, too?"

"Okay, and why does that matter? What makes the bird such a tempting meal to begin with?" This elicits some scrunched up faces and yucks. "Why is it that animals have to eat at all?"

"To survive!"

"For energy!"

"To grow!"

"Good! We can think about food as both a source of energy, and a supply of building materials. And this bird, she was spending a lot of her time eating insects right up until the point that she died, and so her body is still full of energy and building materials. These maggots are making sure that that energy and matter continue to cycle."

"Kind of like recycling!"

The field instructor laughs. "Exactly."

CHAPTER VII

WEDNESDAY BREAKFAST INTERLUDE

Something has changed, has always changed, by the time we all sit down for breakfast on Wednesday morning. For one, students have completed two of the four field study rotations, and are beginning to recognize connections and relationships between different aspects of their environment, noticing new things about an environment that for some is boringly familiar, and for others unquestionably foreign. And, something is being learned that seems simultaneously separate from and integral to this process of recognizing something new. What else, then are these sixth grade students learning?

> *Student leader: They learn how to make a community. They are grouped together, and all of a sudden, you are sharing this cabin with people you don't know…you have to sleep with them, talk to them, make skits with them, sing with them, eat with them, make friends with them… It forces them to look outside of their own friend group, look outside of their own little world they have made for themselves, and see how they can connect with other people, and grow themselves to become better people. And make a community they are proud to be in.*

> *Student leader: [I]t gives 6th graders a new opportunity, to step out of their comfort zones, and this is a big moment to become more aware of the larger world. They haven't looked outside the box yet. This is something that allows them to peek out of the box. And think about the future.*

Student leader: When I was a 6th grader, Outdoor School taught me how to use American utensils.

This morning, part of that change manifests itself in hats, and hats are part of a larger change that I experienced during my field work at Outdoor School. For as long as anyone could remember, there had been a prohibition on wearing hats inside the dining hall. It was a rule, something that felt largely innocuous, a part of tradition, and for some, an issue of respect. It was also arbitrary, and at times, the cause of conflict.

I trace the doing away with the hats in the dining hall prohibition to two different events, while recognizing a history that is far more complex. The first event happened several weeks before, during the first week of the fall session, when we had a class out from a private school in Portland affiliated with the Jewish faith. Students attending this school held a wide variety of relationships with their religion, and many of them followed a Kosher diet. To accommodate this, the school brought their own cook out to site for the week, and served separate food during all meals at an extra table set up in the corner of the dinning hall. And, in a departure from our own taken for granted norms, it is a sign of respect to don a hat, or a kippa, during mealtime.

In order to accommodate that tradition, the hat prohibition took a hiatus during that week.

A week later, the hats off tradition reemerged while hosting a group of five individuals during lunchtime who had worked as Outdoor School staff members back in the 1970's. Such visits were not entirely infrequent, and, in an effort to accommodate these visitors, staff often made an attempt to revive some of the traditions that remained

important to these individuals, and one of these traditions was the prohibition of hats in the dinning hall.

Before all meals, the sixth grade students line up on both sides of the stairs leading up to the dining hall entrance, and one of the program leaders stands at the top of the stairs, coordinating the entry process so as to minimize the inevitable chaos surrounding the entry and seat selection of many hungry sixth graders. The dining hall is organized around long tables that seat up to twelve people. During each meal, several cabins are assigned the duties of host and jump up. The assigning of these tasks is set well in advance with a duty schedule that student leaders carry with them along with an abbreviated schedule to help with the coordination of timing, and during the course of the week, all students will play both of these roles, in addition to setting the tables before meals, cleaning up the dining hall after meals, and tidying up the bathrooms each morning. Hosts are responsible for helping to serve the family style food, and jump ups are allowed to carry empty serving dishes back up to the front of the dining hall for refills.

Hosts and jump ups and staff members enter the dining hall before the rest of the eaters, and so there is always a period of scrambling and searching for seats as the rest of the eaters make their way into the dining hall. The program leader out front invites one line of sixth graders in at a time, greeting each student as they enter, and sometimes, out of habit, asks students to take off their hats.

> *Program leader: So yeah, I was calling kids into the dining hall, and it was the week that the old timers were around… And then I kind of fell back into that*

mode…and was telling kids to take their hats off, and asked this one girl to take off her hat, and she looked at me, stared at me with utter contempt, and went right into the DH. And if she had just ignored me, but the fact that she showed such contempt, and about something I thought was dumb, it led to a conversation between the two of us about following rules for safety's sake, and yet I realized that this rule wasn't about safety at all! And when the two of us got outside for this conversation, I realized that I had picked the wrong battle. She was not willing to talk to me, pulled her hat down, and I was being super stubborn as well. And at the time it seemed like a battle worth fighting, but then I started back tracking, and admitted to her that I thought the rule was dumb too, but I had lost any ability to communicate with her…if that hat is part of their identity, and part of their comfort, it doesn't make sense for us to ask them to take it off…. it works against comfort, as opposed to something neutral or positive, and that became really clear because of that.

The Sunday following the hat incident described above, when staff meet each week before the arrival of student leaders and sixth graders to review the previous week, the topic of the hat prohibition was raised again. All staff members agreed that a tension existed between the message of comfort, of everyone's got their thing, and on the insistence on students removing an article of clothing that may very much be a part of their comfort in a strange setting. At the same time, some staff members voiced the concern that Outdoor School is a place of tradition, and that sometimes those traditions need to be protected. And, the fact that just several weeks earlier, the staff engaged with

a different tradition, one where hats were about respect, and not a lack of, also swirled around the table.

At one point, a staff member posed the following question to the rest of the group:

"Is the idea that hats shouldn't be worn in the dining hall a tradition, or a procedure?"

This elicited a silence, as the group thought about this distinction. I was fascinated by this distinction, and while I am not entirely sure I could explain what this distinction meant, or why it seemed to resonate so strongly with the staff members, but after a moment, someone else said, "It's a procedure!" The rest of the staff members nodded in agreement. And just like that, a rule that had previously felt sacrosanct was overturned.

So this Wednesday morning it felt like more students were wearing hats then not, and I noticed a subtle shift had taken place. When students had arrived on Sunday, in addition the many markers of class and race and gender that students carry with them, there was a clear distinction in how the boys in particular wore their hats. Baseball caps were a common article of clothing, and were worn in ways that revealed variations in style. Some students wore hats with curved brims facing forward, pulled down so that the cap sat squarely upon the head. Others wore baseball caps with the brims flattened, and more often than not facing to the side, resting on top of the head rather than being pulled down. And sometime during the course of the week, these stylistic distinctions began to shift. On several occasions, I watched sixth grade boys playing with their hats during meal times, or while waiting outside the dining hall, flattening the brims, rubbing them between their hands on either side to loosen the arch that had formed over time.

There was also increased experimentation with hat positioning: by Wednesday, very few brims were facing forward, even if the amount of rotation, the overall jauntiness, differed from person to person.

After breakfast, student leaders and cabin groups might have a group responsibility, called a duty, including cleaning up the dining hall, and picking up the common bathroom areas. These activities, dreaded at first, transform into part of this experiment in collective living, in a collective sense of caring for a place, and for others. Inside the dining hall, pop music blares from the speakers while sixth graders fly around, grabbing plates from tables, scraping food waste into a compost bin, throwing away the trash that can not be composted, stacking cleaned plates in large plastic tubs, collecting plastic cups. And they are smiling, occasionally colliding with one another, laughing, picking up the silverware one of their peers accidentally drops, their movements seeming to fall into synch with the music, and with one another.

> *Program leader: You start out on the outside, and you see these people come together and form a cabin group, and get hyped up about something seemingly insignificant like cleaning a toilet, and it makes you want to aspire to be a part of it. You want to be a part of the group that does table toppers, or take part in singing a song, and it calls that sense of you that wants to belong to something, and everyone sort of feels that, and is reaching for that opportunity to be a part of a whole, and I don't think that anyone is ever part of that whole necessarily; even though we never actually become a whole, its just all of us reaching*

Groups without a duty have a little bit of cabin time, time to clean up, to prepare for skits, and to make sure that sixth graders are appropriately attired for another morning of field study. First, however, sixth graders are organized back into four school groups in each cabin area, and then led off to a predesignated spot where they will spend between thirty and forty-five minutes in a class meeting. This is one of only four times during the day when student leaders are not directly responsible for the teaching, managing, and caring for a group of sixth grade students, and I stand on the porch of the dining hall, watching them trudge through the light drizzle towards me. Just as each student leader is assigned a particular field study, and thus staff mentor for the instructional portion of the program, they are also each assigned to one of the program leaders, who act as their mentor and support figure for all things related to the cabin areas, and towards the creation of positive communities.

This time after breakfast and before field study, while sixth graders are with their teachers, provides the program leaders an opportunity to either work in small groups with their assigned student leaders, or sometimes to engage in an activity as a cabin area group. Three nights in and many of the student leaders look exhausted from long days and short nights. But there is also a quiet look of triumph on many of their faces—yes, this work is terrifically challenging, but they have reached the halfway point, and the shift I witnessed in the dining hall this morning is not lost on them. Indeed, it is largely the product of their work, of transforming groups of squirrely sixth graders into something decidedly different.

The student leaders, too, are transforming, and the program leaders are constantly engaged in conversations about the delicate work of bringing people together without

erasing their differences. And, while the program leader team continues to push back against the gendered organization of the program, gender continues to operate in interesting ways. This morning, the male program leaders and student leaders have split into three groups, and are sipping coffee and tea and hot chocolate, informally debriefing the week thus far, talking through the schedule for the rest of the day, troubleshooting any issues that may be arising in individual cabins, and reminding each other that "things worth doing are hard."

On the other side of the dining hall, the female program leaders and student leaders are engaging in a large group conversation. Here, my own body, which at times seems to fade into the background, feels precariously present; I am quite comfortable listening in on the conversations flowing from the groups of gentlemen, and I spend time in the Fir Crest cabin area several times a week. And while I am never asked *not* to sit in on these meetings between the female program leaders and student leaders, or *not* to spend time in the Alder Grove cabin area, I follow these presumed prohibitions anyway. The gendered organization of Outdoor School impacts me too, disciplining and determining my habits of inquiry.

So while I never had the opportunity to witness this myself, I later learn that among the female program leaders and student leaders, a different conversation is unfolding this morning. And, depending on who you ask, this conversation is both inspired by, and a response to, the ubiquity in the male cabin area of the "things worth doing are hard" chant:

Program leader: [The three of us program leaders] got together over the winter. Because we love the 'things worth doing are hard,' and we see that run through the boys cabin area, and it means so much to male student leaders, and it is something the high school boys very much need to hear. This is a hard thing that is so worth doing. And I saw the power in that, and I wanted to be able to give something to the female student leaders, that they need to hear and can carry with them. So we asked, what should we tell them?

Program leader: [The three of us] were thinking about what we want to say to female student leaders, and the whole 'things worth doing are hard thing'— a lot of our girls want to be part of, and included in [something similar], but … I do not want that to be the thing, the chant that my student leaders… they already know too well that things worth doing are hard

Instead, they craft a conversation that circulates around the distinction between an ideal self and a best self:

Student leader: Young women in particular are given this list by society, they need to have perfect hair, skin, say all the right things to everyone, post the right things to Instagram, and it creates this long list of things you need to be. And we wanted to communicate that. And after some silent moments of writing, this concrete thing came to be: how many times do we hear that people are their best self at Outdoor School?

Student leader: Yeah, all three of us have a different way of presenting and articulating the idea… People in general, but girls in particular, have this idea that they can't do things they aren't already perfect at. And while Outdoor School isn't going to break them out of 12 years of being told that, maybe I can plant a seed that at some point will let them try something new… I know a lot of young women who have gotten into this pattern of defining their self worth in terms of their GPA, or their accomplishments, resume, whatever, things that they can point to… The thing I am trying to move towards with my student leaders is instead defining your sense of self by who you are as a person, and I think, you can't really access the depths of that unless you are willing to let yourself feel a little bit more vulnerable, let yourself feel scared and exposed.

On the one hand, these conversations reveal an assumption that the messages high school students need to hear depend on an aspect of their identity determined from the outside. On the other, this recognition of difference feels crucially important. In the midst of organizing a new community, of bringing students together across differences, some differences are not so easily erased or forgotten. Nor should they be. Importantly, this work of transformation that Outdoor School works so hard to make possible does not presuppose a common starting point, nor is it directed towards a singular end.

CHAPTER VIII

FIELD STUDY STORIES, PART II

The emergence and rapid proliferation of fungus reminds us that living things have needs, and that such needs are both mysterious and patterned. At the base of a Douglas Fir, situated just off the main trail from the dining hall to the pond, an explosion of orange chanterelles, brown needles still clinging to their sticky surfaces, delicate gills running in amazingly straight lines from the edge of the caps down towards the earth. Kneel down, and a faint aroma of apricots mixes with the wetness of the soil, the funkiness of decaying matter, the crisp scent of fir needles, the slight sweetness of the fallen maple leaves. And the purple corts, seemingly confined to one particular shady grove of hemlocks; the hemlock snags themselves, decaying from the inside out, covered with the thin white flaps of fairy wing mushrooms. Whenever staff members walk from one place to the next, you can see their eyes scanning the forest beyond the trail, keeping an eye out for the prized *Boletus edulus*, known alternately as the king bolete, or the porcini. Rather than gills, the undersides of the caps reveal a spongy yellow mass, and give off a smell that is deep and earthy. Finding one is a radio-worthy event, and when the "king bolete" call goes out, I always come running to witness the find.

What strange combination of events and qualities accounts for the distribution of these delicate and short lived reminders of all the life we cannot see beneath the surface? Perhaps because these mushrooms don't belong to any one of the field studies, they work to connect them all. Neither plant nor animal, they push the boundaries of what we imagine to be alive, and their precarious distribution reminds us of the distinct qualities, the differences upon differences, the gradients of change, that exist within any single

place. These relationships between and among the qualities of the worlds around us are also part of the learning endemic to this program.

Water

Water field study spills over that fine line our imagination draws between the worlds of nature and those constructed by humans. Water field study begins and ends at Duncan's Pond, and 'pond' is an interesting choice of words to describe a body of water that is stocked with trout, has a paved concrete bottom, and a sluice gate at one end to control the flow of water into the stream that departs on its journey to join the Bull Run Reservoir. This reservoir sits at the bottom of a steep valley that separates the grounds of the camp from peak of Mt. Hood off to the East, and provides nearly all the drinking water for the greater Portland metro area.

The field instructor begins by passing out a collection of more than twenty different types of bottled water, enough so that each pair of students are able to choose one for a closer examination. "As you can see, advertisers have to get pretty creative to convince us in places like the Pacific Northwest to spend money on something that also comes straight out of the tap for free," he says once students have chosen bottles containing images of unspoiled rainforests, with names like EartH_2O and smart water, and advertising claims about alkaline pHs, high oxygen content, and artesian aquifers, of water that has been purified, and of minerals added for taste.

"I want you to be a bit skeptical," he says. "What do these advertising claims mean? Who are they targeting? What seems to matter to the people these advertisers are trying to reach?"

Some groups of students seem to take their consumer advocacy seriously: “Who do they think they are fooling? Water can’t make you smart!” “This one says ‘For Happy Bodies’?” “What does it even mean that this water has been purified?” “Are they adding minerals to cover something up?” “I’ve seen this water bottle before in the stores, and its really expensive, just for this picture of a tropical beach?” “What does ‘artesian aquifer’ even mean?”

Others defend the choice for bottled water: “It just tastes better!” “I really like the way this bottle looks!” “Its safer because you know what it is.” “Remember that time last summer when you couldn’t drink water out of the tap? Its really important to have bottled water around just in case.” “Yeah, we always keep a box of bottled water in the car, and more at home in the garage for emergencies.”

“I’m hearing a lot of good discussion right now,” the field instructor encourages. “And I’m not asking you all to agree, but I want you to think about this thing that many of us buy every day, but hardly think about. I also want you to see if you can find the source of the water in each bottle. Then, I want you and your partner to figure out a story that might describe how this water got from its source, to the shelves of the supermarket where I bought them.”

Students discover water sourced from places as far away as Iceland, Fiji, and France, as well as less exotic locales like Georgia, New York, and Oregon. They talk about trips involving planes and cargo ships and trucks and trains, and wonder about the process of collecting the water in the first place. “Does purified water just come from the tap and then go through some giant Brita system?” “Are there pipes leading from these artesian aquifers to some sort of bottling plant? Doesn’t that disturb the environment?”

"How do you get the water from some mountain in the Alps into these bottles? Is this like melted snow or something?"

"You are all asking some excellent questions, and I don't know the answer to most of them. But lets work together and do a little experiment in modeling. In a moment, when I say 'reverse osmosis,' I am going to ask you to form a line. And the line can be twisting and curving, but it needs to have a clear beginning and end. We are going to imagine that this line of all of you represents the transportation process that you just wondered about. So you might imagine that some of you will represent the collection process, and some of you might be planes, and ships, and trucks; others might be the actual people who are loading and unloading boxes of water bottles, or perhaps workers in some bottling plant who oversee the water as it fills individual bottles. These stories are all different, and they all require that we get this precious resource from one place to another. Reverse osmosis!"

Students stand up and take their places in a line that snakes along one end of the pond, around the benches where they were sitting, and eventually the line is indeed a line, with a beginning and an end. "This line might represent a journey of thousands of miles, or it might be much shorter, as is the case for the water that some of you had that is sourced in Oregon. And of course, depending on its final destination, water from the same source is going to travel different routes. With all of the routes, however, we can imagine that the process of collection, of purification, of adding minerals, and of transportation begins with a certain amount of water, and that, along the way, some of that water is going to get lost. So I have a challenge for all of you. I am going to pour as much water as possible into the hands of the person here at the beginning of the line, and

will ask that each of you pass the water to the person next to you, and lets see if we can move this water from a source to a final destination, wherever that may be!"

The site supervisor walks to the beginning of the line, and the sixth grade student makes a cup with both hands, fingers overlapping on the bottom, and thumbs forming a rim of sorts at the top. He carries a gallon jug of water. "Ready?" he asks? The sixth grader nods her head, and he pours into her hands. All of the water drains out onto the ground, as the rest of the students watch and groan. "Wait, wait, I wasn't really ready, lets try again!" the student urges. And again, the field instructor adds water to her cupped hands. This time, a little leaks out, but she manages to hold her hands over the hand cup of the next person in line, and when they indicate readiness, she releases the water from her hands and it spills into the waiting human cup. Some is lost, but a method of sorts has emerged. After six or so of such passes, there is none left to pass on.

"Alright, lets try a little competition. Here," he says, handing me another gallon jug. "This time, lets start with water on both ends of the line, and see which group can move their water the furthest." I walk to the far end of the line, where the students have been watching, and practicing making hand cups, each of them optimistic about their chances, despite the lack of success experienced by their peers. And there is much cajoling, and some encouraging, as the field instructor and I continue to feed water into each end of the lines, and then watch as the amount quickly decreases while it gets passed towards the middle. Finally, a person in the middle receives water from both sides, though not at the same time, and the group celebrates this accomplishment.

"This is really hard!" some of them exclaim. "And totally not like the real world," someone else comments. "Yeah, I really doubt anyone anywhere is moving water around by passing it from one person's hands to another's!"

"Okay, those are good critiques of our simulation," the field instructor says. "And if our little exercise here is lacking in reality a bit, what about the process of water transportation does it describe well? Or, how is this helping you to think differently about the process of water transportation more generally?"

"Well, water is kind of tricky to move. It's not like something solid, and it is really easy to spill. And I can imagine all sorts of opportunities for spilling along the way."

"Yeah, even when after its in the bottles, they can get damaged. We bought a box of water bottles one time, and one of them had a leak and get my mom's car all wet!"

"It also takes a lot of energy and resources! Even though it's fake to think that the work gets done using people's hands like we did, it still takes people at every step along the way. And think about all the gas it takes to get water from the French Alps to supermarkets here in Oregon!"

"And I heard about this giant patch of garbage in the ocean, and that a lot of that garbage comes from water bottles."

"But you can recycle them, right? And this bottle says it's made with recycled material, so that is a good thing, isn't it?"

"I was getting kind of grossed out by the thought of drinking water touching all of these hands. I get that it doesn't really work that way, but it seems like it would be really

easy for the water to get dirty along the way. How often does it get tested? Just at the beginning?"

"Wow, once again I am blown away by your questions. They definitely go well beyond my knowledge of this process, and I do want to expand a bit on this idea that water can get dirty along the way. Does anyone know a word that we use to talk about the contamination of resources like water and soil?"

A collective shout of "Pollution!"

The field instructor laughs. "Okay, good. And the person who said that there seem to be many places where water can get polluted during the transportation process is right. Water can also become polluted in its natural environment, where the fact that water flows and spreads and moves beyond our control becomes a really important point. For example, what would happen if one of the logging trucks working that hillside up there happened to be leaking oil? What would happen to that oil?"

Students collectively turn and look off to the left, up towards a steep ridge that runs along the west side of the camp property, where muffled sounds of logging are just audible. "Well, since it rains here so much, I guess that oil would probably get carried down towards camp."

"And towards the pond! And the fish!"

The pond is stocked with trout, their brownish bodies just visible beneath the surface. They leap lazily out of the water throughout the day, simultaneously a distraction and a sponge to absorb the wandering attention of sixth graders.

"Hydrologists, or scientists who study water, are very interested in these common points that collect all the water that runs off from the surrounding area. And this pond is

indeed one of those points. We call the area around a common point of water accumulation a watershed, and we are right now in the Duncan Pond water shed! It's a good reminder—any litter, or trash, or chemicals that are spilled in the area immediately surrounding us will eventually flow down into the pond. And if we were to telescope out a little further, we would notice that the Duncan Pond watershed is located within a larger watershed, the Bull Run watershed. Has anyone heard of the Bull Run before?"

"Yeah, that is our drinking water."

"Right, and if you look down off the bluff on the other side of camp, you can see the Bull Run Reservoirs sitting down in the valley below us. Notice that the water from this pond continues on down the hill here as a stream, and that stream does eventually flow into the Bull Run. So its nice that you are worried about the fish, and just as they are impacted by any pollution that might flow into the pond, they also have an impact on everything downstream from them in the larger Bull Run watershed."

"Impact how?"

"Fish poop!"

"But that's natural, right?"

The field instructor smiles. "That is a really tricky word. The trout in this pond weren't born here; they are brought in so that campers in the summer can do some fishing. So while it is natural that fish poop, and there are native trout that live in some of the streams and rivers in this area, this pond here and this large population of imported fish is something that has been introduced to this ecosystem. And it becomes part of that ecosystem, affecting and being affected by all sorts of things. Just like you all are part of this ecosystem while you are here. The idea of watersheds is a powerful one, because it

reminds us that our actions have impacts beyond those that are immediately visible; every watershed is nested inside of a larger one. Does anyone know where the water from Bull Run that doesn't get used as drinking water goes?"

"Umm, eventually the ocean, I would guess."

"And you guess right. From the Bull Run it flows into the Sandy River, and from the Sandy into the Columbia, and eventually out into the ocean." This elicits one of those rare group silences. "In a moment here, you are going to get into small groups with a student leader, and you will learn about some really important qualities of water that can help us determine the overall health of aquatic ecosystems. Each group will test different areas, including the pond, and the water above and below the pond. In the afternoon, we will come back together and discuss our findings.

Students are again sorted into small groups of three or four per student leader, and they head off, carrying large tubes for measuring turbidity; chemical kits for measuring dissolved oxygen and pH; nets and buckets and field guides for examining macroinvertebrates; dissecting scopes for taking a closer look at pond life. There is also a station where students can construct their own watershed, with watering cans and fluorosine die to track the flow of pollution that can occur as rain washes over the impermeable surfaces of our cities and streets. Around the pond there are shouts of laughter, cries of discovery, and also a sense of seriousness as students engage in the careful work of communicating with a natural world we are often told is mute, guided by high school students who seem surprised when I remind them that they are becoming science educators.

Student leader: I think to hear you call us science educators is weird. Science isn't one of my favorite subjects, but when you say that, I realize that I am teaching kids something. And kids look so fascinated, and I think, this is what teachers feel, this idea that kids are going to remember something. And that it is me teaching kids science, makes me happy, because it's not something I'm interested in back at school.

Student leader: The science teacher thing is weird. I don't think that anyone thinks of this as science. Science is this scary thing: there are test tubes, and Bunsen burners, and explosions. But Outdoor School is taking science in a less scary approach. Its more accessible, and hands-on, and you don't always realize in the moment how much you are learning, until you think back.

Student leader: I guess I don't see Outdoor School as science. It's the world.

Student leader: It's really cool to come out here and have both student leaders and 6th graders that are so passionate about what they are doing. I had one experience when I came out last session, and I am really big on the whole cycle of everything, and global inter-connectedness, and I had one 6th grader who I could tell just got it. In her mind, she was like, "Oh my gosh, that makes so much sense! What I do here affects the water in China! I can save the whole planet!" and I was like: "yes you can

Soil

Student leader: And for me, on soil, all the things I do are scientific method oriented…. having students do an experiment, and saying: 'what did you see, and what do those observations actually tell you about the world?'

Student leader: Today, one of my students was interested in sonic the hedgehog. And I was teaching about soil and pore space, and I was able to make connections between hedgehogs and pore spaces and soil, and it just felt really good.

Student leader: And on soil, if you make the connection that without weathering there is no life, it blows their minds, about how simple actions can impact their environment.

Thursday morning, and students are trying to wrap their minds around the idea that 'dirt' is different from soil. A four-time returning senior has been invited to give the introduction, and she holds a large laminated circle in one hand, standing in front of the sixth grade students sitting on tiered logs. The ground behind her drops off steeply towards the Bull Run Reservoir, and clouds and mist swirl slowly, obscuring the bottom of the valley below. The sky is overcast, and against its thick greyness, the peak of Mt. Hood stands stoically, almost purple in contrast. This place is known as the bluff, and is

situated at the center of the various activities and stations that comprise the rest of soil field study.

"Soil is a really special thing," she begins, "because it both nourishes all of the life you see around us, and in return, it is nourished, and constantly replenished, by those very same things." She reaches down to the ground, just as she has seen the field instructor do countless times before, and picks up a handful of soil. "Trees, the rain, air, and the mountain— all of these things have a role to play in making this special substance, and one that we often overlook. So I want you to all do a bit of initial exploring and observing; reach down to the ground below you, and grab a handful of soil." She waits while students tentatively reach down and scrape their hands across the ground, some forming a fist to lift up their sample, others using their spare hand as a receptacle as they carefully sweep up bits rock and fir needles and duff. "And I want you to look at it. Notice that the soil is not made up of one thing, but rather is a mixture of different parts, and no two handfuls will be exactly the same. Roll it around between your hands, feel the different textures. And, if you are feeling brave, give the soil a bit of a sniff. What different kinds of smells do you notice?"

The enthusiasm for this seemingly mundane activity begins to build, as it turns out even the ground beneath our feet holds some surprises. "Turn to your neighbor and share some of your observations." And so students discuss individual fir needles, and bits of cone, and chunks of rock, and grains of sand, and pieces of stick, and something chalky, something grainy, something sharp, and something smooth; they share the sharp scent of fir, the slight metallic tang of the sand, and that pervasive deep earthy smell that is at times bitter, and at others sweet.

"Now that you have all taken some time to observe the soil, let's talk about the different ingredients that you observe." She holds the laminated circle up in one hand, and with the other, she picks up a large ziplock bag containing pie shaped pieces of various sizes. "Soil," she continues, "is composed of four main types of ingredients. I heard a lot of you notice the sticks and cones and needles and decaying leaves in the soil. All of those things were at one point alive, and so we call those things 'organic matter,' and that is one of our four ingredients. What percent of soil would you all guess is composed of organic material?"

Students shout out numbers, ranging from 25% to 75%, and look slightly puzzled when she pulls out a small slice of pie, and attaches it to the circular poster via Velcro. The piece reads "Organic matter, 5%."

"I heard a lot of you guess that the amount of organic matter would be much greater. Any ideas about why our observations might not seem to match this number?"

"We were only looking at the surface," a student shares from the back. "I kept digging while you were talking, and found a lot more rocks farther down. The tree parts and things fall on the top, and I guess that's the part we see."

"Excellent observation!" she says. "So let's talk a bit about those rocks you saw. You probably also saw smaller pieces of rock, and maybe even some sand and clay. Those ingredients were never alive, and so we call them 'inorganic matter.' What percent of soil would you guess is made up of inorganic material?"

A very confident shout of "95 %!" comes from the front row. Other students look less sure, but the math certainly works.

"That is a good guess. And inorganic matter does make up the largest chunk of our soil pie here, but it is actually only 45 %." She pulls a large piece from her bag, and attaches it to the poster next to the 5% sliver representing organic materials. "Two more ingredients remaining. And these ones are a bit trickier…"

Some students look down at the soil in the hands for clues, until someone says "Rain! My soil is definitely wet!"

"Yes! And if you all think about the fact that plants grow out of soil, and that soil provides plants with water and nutrients, it makes sense that soil must contain water, too." She pulls out another slice of the pie. "Water makes up about 25% of soil on average, although this clearly depends quite a bit on factors like weather and climate. That leaves one piece left. Any ideas?

"Nutrients?" someone asks hesitantly.

"That sure makes sense from what I just said about the needs of plants and their relationship with soil, but those nutrients are represented by both the organic and inorganic components we already have here."

"Animals?"

"Those are organic!" someone else responds.

"Animals are a great guess," the student leader redirects, "and while animals are certainly a source of organic material, and many types of animals do live in the soil, that is not the missing ingredient that our model is based on. But thinking about animals might be helpful. What else besides food and water do animals need to survive, even those that may be living below the surface in the soil?"

This elicits simultaneous shouts of: "Air!" "Oxygen!" "Space!"

The student leader laughs and she pulls the final piece of the pie out of the bag and attaches it in to the circle. The piece reads "Air," and beneath, "(pore space)." "Makes sense, right?" she asks. "Pore spaces allow air from the atmosphere to mix into the soil, and it is also these pore spaces that account for the fact that when it rains, some of the water is able to seep into the soil.

"So you now know the four main ingredients we need to make soil. But are we really done with our explanation? Let's try a little experiment." She reached back down to the ground, and picks up a stick and a rock. She holds the stick in the air. "What part of our soil does this stick represent?" she asks?

"Organic material!" the students respond in unison.

"And this rock?"

"Inorganic!"

"Good, so we are half way there. And air is pretty easy, right?" And she mimes blowing air over the rock and the stick. "Which means that all we need is some water, right?" at which point she spits on her hand, and students dissolve into "yucks" and laughter. "So is this soil? I've got all the required ingredients, right?"

Students settle down from the humor of bodily fluids, and think about this question, clearly wary of a trick. "Let's keep thinking about this question using our model, which presents a sort of recipe here for making soil. It tells us what ingredients are needed, and in what amounts. And, according to our model so far, all we need to do is mix these ingredients together, and then we get soil! Maybe some of you have done some cooking in the past… What is missing here? What is our model not accounting for?"

"Well, recipes usually have a section where they explain how to combine the ingredients, in what order. And it also usually has a section on cooking. A cake isn't a cake until you bake it, even though I do like eating cake batter…" The student laughs.

"Excellent! So what would need to happen to my stick and my rock and the air and the spit for it to become soil?"

"Time!" someone shouts.

"And a giant blender that could crush up the rock and the stick!"

More laughter. "You all are funny," the student leader says. "And not at all wrong! Today you are going to have an opportunity to explore the processes responsible for breaking organic and inorganic material down into pieces that look more like the bits you observed in your hands a moment ago. And the time part is also really important. Scientists estimate that it takes between five hundred and one thousand years to form just one inch of new top soil! Hopefully that gives you a new appreciation for this amazing material that just a little while ago you wanted to tell me was the same thing as dirt!"

Like water field study, the remainder of soil field study is set up around a variety of station based activities that student leaders can choose from, and as they progress through the week, many of them find strategic orderings that help students recognize the relationships among the various qualities of soil that they explore. Students explore physical and chemical weathering, smashing boulders with rock hammers and watching as vinegar fizzes and bubbles as it reacts with calcium carbonate. A trip down to the steaming compost pile, situated behind a double layer of fences to keep bears and other pests out, reveals the rotting remains of food that students have seen themselves in the dining hall over the course of the week. Together, these two experiences provide

students an opportunity to think about the slow processes by which organic and inorganic matter break down. No blender needed.

They visit the hillside below the bluff, where erosion has revealed a profile of the different layers of soil. They compare the particle size and pore spaces that exist in silt, sand, and clay, and create models to show the relationship how larger particles create larger pore spaces that allow for the mixing of air and water. They conduct experiments to test the relative absorption and compaction of different substrates found around the camp grounds, watching as water quickly seeps into the relatively large pore spaces found in a sandy pit near the bluff, or puzzling at the way clay-rich soil in another area seems to repel water entirely.

Field studies typically involve a wrap up activity of sorts, and the soil field instructor has crafted one that invites students to engage in some collective imagining that nearly always brings a tear to my eyes:

> *Field instructor: One of things that I wasn't doing was making connections to careers in soil science and geology. So I thought, OK, there is soil in space! My field study is huge! It's the universe! And space has always been a passion of mine, space exploration. Twelve people have gotten to the moon, and they got there through hard work, and science, and taking risks, and in the future, people are probably going to go to Mars. And how cool would it be if ODS was mentioned by our next Astronauts? [Laughter]And it excites me. Not just the prospect of leaving Earth, but even as an amateur, I can contribute to the exploration of space by inspiring the next generation to pursue that… [During my*

wrap up] I ask them about the last person to visit the moon, who was a geologist, and that was a pretty different time in space exploration, with our history and the cold war. And now we do send scientists to space. Buzz Aldrin said, sometime recently, that the person to walk on Mars is probably a middle schooler right now. And I tell them that the rover on Mars is doing very similar soil tests to what students do. And I talk to them about how life as we know it, in our small frame of reference, requires soil, but I also want them to open up the idea that maybe soil is not always necessary for life, that its an Earth centric framework

This wrap up discussion of soil and space takes place back on the bluff, and I always try to find a place to watch where I can see the reactions of the sixth graders. When they are told about Aldrin's prediction that the first person to walk on Mars is someone their age, this visible change sweeps over them. Eyes light up, smiles spread across faces, and the realm of science expands beyond a collection of facts and procedures, and towards an act of collective imagination.

CHAPTER IX

LEARNINGS

I want to begin by emphasizing that while the stories I have told are an attempt to use beings of fiction to articulate the experiences of Outdoor School beyond the confines of their cognitive dimensions, they are hardly free of analysis. Instead, they are assembled within the swirl of theory and my empirical engagements with peoples, places, and the non-human components of a complex learning environment. I don't pretend that these stories provide some direct and unmediated access to the workings of this program, nor are they definitive and exhaustive descriptions of the multiple ways that ODS came to matter in the lives of the many individuals and groups I witnessed take part in this experience. Rather, I hope that these stories are themselves performative, giving rise to plural experiences, where the production of multiple reading experiences works hand in hand with the theory of a nature untethered from a singular ontological conception. That being said, I am not asking that the beings of fiction that populate these stories stand in for the production of knowledge. This is a different task, and one that I seek to address here more fully.

Throughout this dissertation, I have turned to the pragmatist reconstruction of experience in an effort to value transactions with worlds that do not fall squarely within the realm of knowledge and epistemology. This turn towards ontology has been a central component of both my efforts at reconstructing the aims of science education, and my methodological approach to fieldwork and qualitative research in education more generally. However, I want to be clear—this turn towards ontology is not a rejection of epistemology, nor is it in response to the unknowability of the worlds we inhabit.

Instead, I want to emphasize that knowledge is but one mode of existence, albeit a terrifically important one, so long as we make room for other modes of being and aspects of experience that for too long have been squashed by our obsession with all things cognitive and epistemic. Once again, Latour (2013) offers some help here:

> This impression that there is always something *more* that what is known in the thing known does not refer at all to the unknowable… but to *the presence of other modes* whose equal dignity EPISTEMOLOGY, despite all its efforts, has never allowed to be recognized. Knowledge can grasp everything, go everywhere, but in its own mode. It is not a DOMAIN, whose expansion has to be limited or authorized. It is a network that traces its own particular trajectory, alongside other, differently qualified trajectories which it never ceases to crisscross. p. 85

I do believe that my inquiry experience is up to the task of knowledge production, where knowledge is produced through tentative trajectories, involving selections and pathways that could have been otherwise. This production of knowledge certainly does crisscross in and through the stories I have told, and serves a different diplomatic purpose. That is, just as I hope that the stories in the previous chapter enable a discussion of ODS that resonates with those responsible for its performance, including those who may perform new versions of ODS in the future, I charge this section with expanding the work of diplomacy towards those collectives responsible for the practices of science education, and the production of science education research and policy more broadly. To do so, I will use my experiences as both a classroom science teacher, and an educator working to prepare future science teachers, as points of reference and opportunities to put the practices of ODS into conversation with more traditional approaches to science education.

I frame this production of knowledge in terms of two different tasks. First, following the methodological approach of case study and ethnographic work in science

studies, "where theory and data are created together" (Law, 2008, p. 630), I begin by offering a more explicit attempt at building a theory of multinatural science education. I want to emphasize that neither the program in general nor individual staff members are or were using the language of multinaturalism to discuss their work. Instead, I suggest that multinaturalism enables a particular discussion of the practices of this ODS program, grounding them as valuable resources when wrestling with the work of articulating a positive political project for science education in general. Further, this ODS program may be only one of many sets of practices that provide examples of a multinatural science education; the goal here is not to point to a definitive best practice of multinatural science education, nor do I wish to imply that multinatural science teaching and learning is only possible outside of traditional school environments. Accordingly, the second part of knowledge production involves extending this analysis outward, and inquiring into the ways that the practices of this ODS program may inform the practice and policy of science education more generally.

Towards a Theory of Multinatural Science Education

I will focus on three different aspects of the teaching and learning that unfolded at this ODS program, using the theoretical framework of multinaturalism to better explicate the following: the nature(s) at play in the learning environment; the relationship between the science being taught and those nature(s); and the relationship of teachers to both nature(s) and their students. In order to denote how these three components of teaching and learning at ODS are unique, I begin by referencing a short description of my practice as a high school science teacher. Importantly, I believe that the practices I describe were

largely successful given the contemporary parameters of evaluating science instruction; in particular, my practices fit with Duschl's (2008) call for balancing the conceptual, epistemic, and social aims of science education. At the same time, I also demonstrate how my practices held onto an ontology of mononaturalism. I engage in this counterexample not to spurn the science teaching and learning more typical of traditional schooling, but rather to emphasize how an emphasis on ontology offers both an opportunity to problematize and reconstruct the aims and practices of science education.

Classroom Science and Mononaturalism

When I taught high school science, I both loved and hated the delicate work of guiding students through meaningful inquiry experiences. On the one hand, asking students to develop and implement empirical investigations felt like an essential part of moving beyond a science education based solely in the transmission of static knowledge. Instead, students were able to practice the same types of techniques and methods that scientists use in the production of knowledge, confirming and exploring the empirical work that undergirds scientific facts and theories. On the other, there were aspects of students' practical work that always left me feeling dissatisfied and disconcerted. In particular, I was frustrated by a constant refrain I heard from my students: more often than not, their experiments failed to *work*.

What did this mean? In other words, what precisely wasn't working in my students' attempts at engaging the phenomena of science through their own empirical explorations? In short, the problem could be summarized as follows: my students often felt unable to coax the natural world into behaving in the singular and definitive way that is so often described by text books and laboratory manuals. Typical laboratory

experiences in my high school classroom often followed a particular format: I would begin by offering students a conceptual and theoretical introduction to the phenomenon we were considering, emphasizing the historical developments that led to our contemporary understanding. Next, I would introduce or review laboratory techniques that enabled students to measure the influence of relevant variables on said phenomenon. For example, in a unit on photosynthesis, I covered relevant science about the nature of light, the cellular mechanics responsible for transforming light energy into chemical energy, and how variables like environmental concentrations of carbon dioxide, the frequency of light and its intensity, and pH, influence the larger process. I offered students various species of plants species to investigate including aquatic ones, which are convenient because it is much easier to measure and manipulate an enclosed container of water than the air surrounding terrestrial plants. I taught students how to measure photosynthetic activity indirectly in aquatic plants, by monitoring consumption and production of oxygen and carbon dioxide. With the terrestrial species, students could use a procedure that bleaches leaves of their chlorophyll before dyeing them with iodine, which can demonstrate the presence and relative amounts of starch, another product of photosynthesis.

After this introduction to concepts and techniques, I asked students to design laboratory investigations exploring the relationship between relevant variables and photosynthetic activity. This took the form of an in-class essay, meeting the requirement of assessing individual learning demanded by schools. After students submitted their designs, I grouped them around similar experimental procedures, and sets of three to four students worked collectively to determine a set of procedures that would provide enough

data to answer each of their individual questions. Or, if they chose, they could reformulate an experiment that combined different elements from each into one complex investigation. Students had the following three days of class time to conduct their experiments, and the following week would present their findings to the rest of class.

For example, I recall a group of individuals who had designed similar experiments about determining the action spectra of different species of aquatic plants. Action spectra are graphs that compare a plants' photosynthetic activity across the spectrum of visible light, and typically contain two distinct peaks representing high photosynthetic activity corresponding to blue and red light, and a valley indicating relatively low levels of activity with green light. These different peaks correspond to the activity of different types of photosynthetic pigments that plants have evolved. During their meeting, one student brought up the fact that water changes the quality of light, where the red end of the spectrum, with the longest wavelengths, is increasingly absent as depth increases. Accordingly, the students predicted that aquatic plants in general might produce fewer of the pigments responsible for absorbing red light, and thus have action spectra that look different from terrestrial plants.

This is precisely the type of careful thinking I hoped students would demonstrate in their design of experimental work. It demonstrated a clear understanding of the science behind photosynthesis, avoiding the dismissal of conceptual rigor that scholars of science education often attribute to the Discovery-Inquiry model. For example, Windschitl, Thompson, & Braaten (2008) discuss how an emphasis on inquiry often leads to experimental work that fails to reflect a nuanced understanding of science—think of the all too common example of students watering plants with various types of sodas,

without any conceptual model explaining why or how soda might influence plant growth in the first place. These students, on the other hand, designed an experiment that demonstrated fluency with both the epistemic practices of science, as well as the conceptual model of photosynthesis. Yet, after several days of data collection aided by the use of digital probes, enabling measurements of photosynthetic activity by monitoring changes to the dissolved oxygen in the aquatic environment surrounding plants exposed to light with controlled wavelengths, the students in this group reported to me that their experiment had failed. The data they collected showed more variation than expected within light conditions, and nothing near the variation they expected across light conditions. The average photosynthetic activity under each light condition was roughly the same. In other words, the students did not accomplish the double rupture that marks the work of Science—they were unable to access the world of universal nature and deliver back its stable Truth.

Accordingly, students in this group wrote about their "false findings," and worked to explain away these erroneous results, identifying "sources of error" in their experimental procedure, the complicated workings of the digital probes, anywhere other than in the nature under investigation. Despite my attempts to encourage students to imagine why they got the results they did, rather than denying the reality of their carefully recorded experiences and observations, such analysis rarely if ever made its way into their explanations. Importantly, the aquatic plants that these students used in their experiment were taken at random from a large freshwater tank I kept in my classroom, and the same individual plants were being used in experiments throughout the day. In other words, this nature had a history, and there were many reasons why the

individual plants might not behave in the manner predicted by a Science directed towards revealing a universal and static natural world. While this history was clear to me, as I witnessed the plants throughout the day, I unwittingly created a learning environment directed towards an ahistorical and singular nature. And because of this singular Nature, students were stuck practicing a universalizing Science, which treated their empirical investigations as spurious when they failed to match the results specified by theory. Finally, because this theory was precisely what I had emphasized in my instruction, granting it with the authority of Science in general, and the authority of my particular role as teacher of Science, it is hardly surprising that students felt unwilling to defend the reality of their own observations against the weight of this authoritative Truth.

I felt deeply frustrated, as did students who consistently found discrepancies between their experimental results and those they predicted based on theories of a singular nature. At the same time, I felt that my practices themselves were sound. I had introduced students to multiple methods for measuring photosynthesis, as well as multiple variables to explore in connection to this process, and I believed such activities enabled me to evaluate students' understanding of the concept of photosynthesis, *and* the epistemic practices responsible for this conceptual knowledge. Further, I found ways to balance the social aims of science, which emphasize collaboration and collective action, with the requirements of individual accountability required by the institutions of schooling. At the time, I had no conceptual framework for surfacing these tensions in a way that provided me a way forward. Accordingly, I turn to the practices I evoked in the short stories of the previous chapter, and use the framework of multinaturalism to make sense of how these practices provide a different orientation for science education, one

that avoids positioning the authority of science and science educators over the empirical experiences of students.

Curricula as multinatural learning environments

It is difficult to discuss the multiple curricula of this ODS program as isolated entities, as they are always intra-acting (Barad, 2007) with the pedagogical styles of individual field instructors, the ever changing groups of student leaders who perform the majority of the teaching, as well as the unique groups of learners whose questions and interests also inform the particulars of the plural educational experiences that unfold. At the same time, sticking to the literal definition of the word curriculum, which refers to the physical pathway or course through which learning occurs, there is a sense that at ODS the physical environment of the site *is* the curriculum. In other words, each of the field study units is inseparable from the places where it occurs: there are no text books, no lesson plans per se, and the learning and teaching is largely directed by the movement of individuals through different locations of each site. At first glance, this may appear similar to the early conception of science education as nature study, where direct access to the natural world alone, in its universal splendor, was sufficient conditions for learning. However, I argue that the physical learning environments of this ODS program are mobilized in ways that trouble the nature/ culture binary that upholds an ontological position of mononaturalism. Instead, as the boundaries between the two are blurred, students are introduced to multiple natures that are equally real, and equally consequential, enabling the development of a scientific literacy that is multinatural.

All of the spaces where learning unfolds at this ODS program, described in greater detail in the previous chapter, contain interesting mixes of things often deemed both natural and artificial. The plants hike, for example, offers students an opportunity to experience and explore native plants in the setting where they have evolved and continue to flourish. At the same time, the path that the hike follows is clearly a human artifact, as are the laminated placards that help with the identification of plant species, the bridges that facilitate the crossing of streams, and the signs that offer guidance in several places where the trail forks. The stations that make up the first half of animals field study are clearly human efforts at curation and collection, and yet the bones, pelts, antlers, and skulls that make up these collections are objects typically classified as natural. The pond that centers the activities of water field study is another interesting amalgamation of human and natural forces. The pond is paved in cement, and created by a sluice gate system that controls the flow of water to and from the pond; the pond is fed by a natural spring, and the water that leaves at the other end joins back up with this stream on its way to the Bull Run reservoir. Soil field study similarly blurs the line between natural and artificial, attending to the ways that human activity contributes to weathering and erosion and soil quality more generally, including the intentional acts of composting and adjusting the pH of soil in order to support the needs of particular crops. A focus on such interactions troubles the existence of a pure and singular world of nature that exists separate from the activities of humans, emphasizing instead emergent natures that are always in flux.

Unlike the early tenets of a science education based on nature study, where nature as a monolithic entity was both curriculum and teacher, this ODS program offers a

curriculum that examines multiple natures that emerge when different aspects of the environment are emphasized. The particular framing of each field study produces an engagement with a different nature; as the emphasis shifts from plants to animals, and water to soil, different science concepts and concerns come to the fore. And while each of these natures emerges differently, students are also constantly reminded of the interdependence and relationships between and among the various constituents and collectives at play. Indeed, some sections of the site serve multiple field studies, so students may spend time along a trail during animals field study, collecting and examining invertebrates, and return later to that same trail during soil field study to examine the relative compaction of the soil on and off the trail. While the trail that serves as the curriculum in both instances is the same physical space, the nature that emerges through each set of interactions is distinct. In the first, the natural space is framed as a habitat for insects, emphasizing how the area as a whole emerges as a micro-ecosystem that provides food and shelter for various species. In the second, the unity of the micro-ecosystem is challenged by examining difference—the soil found on the trail is markedly distinct from that found underneath the ferns at the edge of the trail, which is different from the soil beneath a stand of Western Hemlocks some distance further from the trail's edge.

In addition to the multiple natures emphasized across the four different field studies, there are also different natures present within the field studies themselves. Perhaps the most obvious example exists in the curriculum of plants field study. In addition to studying the characteristics of plants in their natural habitat, students also explore the various ways that plants have been used in human cultures. There is an

emphasis on ethnobotany, and students try teas made from local plants, and discuss how various trees provide the raw materials to construct objects ranging from bows and arrows to clothes and canoes. Students also explore more contemporary uses of plants, and practice using various logging tools, including crosscut saws and shingle froes. Similarly, water field study provides students with an opportunity to study the components of aquatic ecosystems that enable them to support non-human life, while also emphasizing the profound importance of water and watersheds for human activity. Indeed, that the strange cement-lined pond is simultaneously home to trout, newts, and a wide variety of aquatic insects, while also being directly connected to the Bull Run Reservoir that supplies the surrounding metropolitan area with all of its drinking water, exemplifies the possibility of a space that belongs to multiple natures.

Finally, the conceptual material that the field instructors emphasize also plays a role in destabilizing a static and universal nature. Perhaps the most obvious example is the introduction to plants field study, where the seemingly solid categories of plants and animals are troubled by the presence of a solar powered sea slug. The unavoidable encounters with fungi continues this work, as students are exposed to a kingdom of life that is almost always absent in formal science curricula. Steven Jay Gould (1977) reminds us that up until the late 1960's, fungi's rootedness to the ground cast them in with plants. Done, difference reconciled. However, as the sciences that inform our taxonomic schema shifted from an emphasis on structural similarity and towards ecosystem relationships, new differences emerged: fungi are relationally unique, fitting neither the categories of production nor consumption, and instead performing the crucial work of decomposition. The act of decomposition is such a great reminder that nature is

both "stable and precarious" (Dewey, 1981), a process whereby the seemingly eternal and individually definite bits of nature are broken down and assembled anew. When students watched as maggots and ants ate away at the flesh of the dead bird, they were witnessing first hand how seemingly immutable matter is always in the process of becoming different.

Multinatural Learning Environments and Difference

For some, this recognition of plural natures is problematic, and professor of philosophy Michael Zimmerman (2012) notes how the concept of multinaturalism is strongly opposed by a group he calls Old Time Environmentalists (OTEs). Members of this group, who Zimmerman also note tend to be white and male,

> insist that there *is* One True Nature, that it is objectively *real*, and that it is best exemplified by *wilderness*, defined as virgin land untrammeled by humans. Such wild nature is allegedly stable, enduring, harmonious, balanced, beautiful, and replete with inherent value. Because of multinaturalism, however, OTEs have had to contend with competing ideas about nature, including those that don't put wilderness protection—or even global climate change—at the top of the environmental agenda. n.p.

It is not difficult to imagine a residential outdoor science program holding tightly to such a singular conception of nature, justified by its emphasis on environmental advocacy and the need to protect nature from the destructive forces of humans. There are certainly elements of such an environmental ethos in circulation at this particular ODS, but this is not the only conception of nature students are offered. Further, I argue that moving away from this singular conception of nature is an important part of the work that this ODS program has done to support diverse learners.

In her book *Black Faces, White Spaces,* Carolyn Finney (2014) discusses how the constellation of historical memory and the forces of racialization and representation work to exclude people of color from engaging in both environmental recreation and advocacy in the United States. That is, she describes how the natural environment is always already a racialized space, where "[t]he emerging narrative that defined 'the Negro's place in Nature' … place[s] black people at the bottom of the evolutionary rung while reifying whiteness as closest to God, thereby morally justifying any act of exclusion" (p. 39). Finney's analysis helps counter the claim that nature is universal and neutral, and demonstrates how ecology movements that adopt the position of mononaturalism, of nature as free from the human influence of politics, ignore the lived experiences of people for whom nature has come to matter in different ways. Importantly, within the small group learning that takes place at ODS, where students from different schools are actively exploring natural worlds together, the different natures they carry with them also become part of the learning environment.

At the same time, I want to stress that group work alone does not automatically enable students and their unique conceptions of both nature and culture to contribute to learning environments in meaningful ways. In other words, collaboration and community is not something that simply emerges when students are removed from the individualizing habits of traditional schools. As Dewey (1989) reminds us, the "belief that if only artificial social conditions could be got rid of human nature would produce almost automatically a certain kind of social arrangement" (p.24) ignores the relational quality of both nature and culture. Instead, along with the science learning that is emphasized across the different field studies, this ODS program explicitly teaches

students how to function as a community, how to engage one another through differences, and not by denying them. This is slow and difficult work, and rarely receives the attention it requires in school settings where the limited instructional time is increasingly directed towards singular goals of academic rigor and accountability. I noticed that in comparing the teaching and learning that occurred during the half- and full-week programs, the portion that was specific to science learning emerged relatively unscathed. While the time to explore each field study was shortened, they continued to experience the multiple natures that emerge from the unique physical aspects of the program's learning environment. Instead, it was the piece of learning how to learn together, of enabling individual differences to become compelling parts of the learning environment, that suffered most. In other words, during the half-week program, Wednesday breakfast never happened.

This subtle blurring of the nature/culture binary and the multiple ways that the curriculum at ODS works to erode a concept of nature as a single entity with clearly defined boundaries has important implications for the study of learning environments in science education. Much of the scholarly work on learning environments in science education remains firmly wedded to a humanist paradigm, where only individual humans are capable of exercising agency. Consequently, learning environments are studied as one-dimensional contextual veneers to human action, reducible to quantifiable surveys and checklists (see Fraser, 2012). And while place-based approaches to education (eg. Gruenewald & Smith, 2008; Stevenson, 2008) have sought to emphasize the importance of the natural spaces where human activity unfolds, Nespoor's (2008) review of this literature reveals important limitations regarding the theorization of place, nature,

community, and difference. Nespoor emphasizes the tendency within this movement to construct overly simple dichotomies between places and non-places, imagining the former as idealized natural locations that somehow resist the cultural trappings of hegemony and capitalism. Accordingly, nature is equated with utopian notions of community wholly separate from hegemonic discursive and material structures, which only serves to obscure the ongoing relationships of power and difference always at play (see Lugones, 2006). Instead, this ODS program works to actively reconstruct community, reminding students that "everyone's got their thing," and that such things are differences to be embraced and emphasized.

In the final chapter of *Black Faces, White Spaces*, Finney suggests that the exclusionary relationships between people of color and the natural environment must be transformed: "We can rebuild our human/environment relationships through examination of our existing relationships to each other, different communities, our social norms, narratives and beliefs, and the natural environment" (p. 132). It is in this sense that the curricular learning environments of ODS work together as a being of metamorphosis (Latour, 2013). In other words, the learning environment is not simply a place where multiple natures exist, but rather a being that enables students to renegotiate their relationships with difference across the categories of nature and culture. The multiple natures are performed, not found, and are the complex product of relational environments composed of both human and non-human elements. In turn, the performance of multiple natures provides students an opportunity to practice plural sciences, instead of memorizing and confirming the content of a singular Science.

The Sciences of ODS and Multinatural Scientific Literacy

Multinatural learning environments enable students to practice sciences instead of memorizing Science, resulting in a scientific literacy with two particular aims/ components/ features. First, the singular Nature towards which a unified Science seeks to represent is often positioned as a mute object. According to this ontology, the majority of humans can only access Nature through the representations offered by scientists, and scientific literacy is thus positioned as the ability to read and understand those representations. Instead, ODS follows Latour's (2013) urging for us to become materialists at last by directing our attention towards plural natures that are always already articulating:

> That the world is articulated and that this is why we sometimes manage to take up certain of its articulations through the intermediary of expressions, only an infinitesimal number of which are produced through the channel in which air currents slip past the glottis—is this not a more realistic, more economic, more elegant hypothesis than imagining a human projecting from his head signs lacking any purchase on an inarticulated material world?

The stories that I tell of plants and animals field study are particularly demonstrative of natures in the process of articulating. In other words, while differences between Douglas Firs and Western Hemlocks, or reptiles and amphibians, have been codified into scientific knowledge, they are not simply projections of human thought onto a non-human world. Instead, such differences can be read from the articulations of the beings themselves, and not simply from the representations offered by scientists. Rather than reading and memorizing representations of Science, students can practice an observational science, learning to become literate within natural worlds where difference is in the world, not imposed on a uniform nature by human minds alone.

Second, this ideal of Science as representation is further entrenched by an emphasis on the qualities of nature as fixed and permanent, rather than relational and emergent. Again, within this ontological orientation, scientific literacy is concerned with either knowing those fixed qualities, or mastering the epistemic practices by which such qualities can be revealed. And when our practices of science reveal something other than those singular qualities, we deny the reality of our experiences and observations in order to uphold the Truth of those representations. This is precisely the source of the disconcertment I describe in the vignette of my classroom practice. Importantly, the observational science described in the paragraph above is not the only version of science being practiced at ODS; students are also engaging in experimental work that enables additional inquiry into the qualities of nature, but this experimental work is not directed towards confirming fixed qualities, but rather revealing the relationships between them. For example, on water field study, students learn how to test qualities like dissolved oxygen, pH and turbidity, and perform these techniques in order to compare the water in the pond and the water in the stream that flows into and out of the pond. During soil field study, students use a simple technique to measure the compaction of soil, placing a metal cylinder on top of the soil and measuring the time it takes for a controlled amount of water to be absorbed.

In both activities, students are performing experiments, collecting data, and offering tentative conclusions; however, unlike the experimental work that occurred in my high school class, the results are not valued by the degree to which they match or confirm some fixed quality, but rather their ability to engage with natures that are both relational and articulated. I continue to wonder how my identity as both as a scientist and

an educator complicated my ability to offer students access to multiple natures within my practice as a classroom teacher. While I think I did make attempts as a classroom teacher at troubling the universal and ahistorical framing of science *and* nature—assigning readings from thinkers like Steven Jay Gould and emphasizing evolution as a theory of nature that is both historical and relational— I certainly spent much more time delivering seemingly static facts and theories about the external world. Indeed, as a relatively young teacher, and one who always struggled somewhat with traditional classroom discipline, I used my knowledge of science as a source of authority. Locating that authority away from my own body felt safer and more comfortable to me at the time, and I now recognize that this choice had unintended consequences concerning my ability to teach towards multinaturalism.

Educators-of-Sciences, not Scientists-as-Educators

During the group interviews I conducted with high school student leaders, I often asked them about their work as science educators. More often than not, the student leaders responded to this line of questioning with puzzlement—the idea that they were teaching *science* was one that many had not explicitly considered. On the one hand, this was troubling, as it is tempting to frame an equitable science education as one that enables all students to envision themselves as scientists, or at least science educators. Indeed, this is part of the *Science for All* rhetoric that often dominates conversations about the social aims of science education. On the other, I argue that it reveals just how differently these individuals understood the teaching and learning that happened at ODS compared with the science learning that they themselves experienced in school settings. That is, if most of these high school students continued to think in terms of a singular and

authoritative Science as objective representation of nature's single Truth, maybe their reticence to imagine themselves as sources of scientific knowledge is not such a bad thing, especially given the complex practices of the sciences that these student leaders were undeniably teaching.

In other words, the student leaders offer a version of science teaching and learning that is distinctly different from the paradigm of knowledge transmission. Most of them are unapologetic about their lack of precise scientific knowledge; yet, they guide sixth graders through practices that are undeniably *scientific*: learning to describe and identify plants and animals, recognizing both the usefulness and limitations of classification systems; measuring the qualities of soil and water systems, and using such qualities to examine relationships rather than confirm immutable laws of nature. And of course it matters that these student leaders are not much older than the sixth graders they are teaching, that they often come from the same neighborhoods and attend the high schools that the sixth graders will one day attend. It also matters that the learning occurs in small groups, necessitating a different type of authority than is often required to keep classes of thirty students silently listening to the delivery of information more typical of learning in classroom settings. Finally, the plurality of the student leader population, of their offering many different versions of being a high schooler, a mentor, a science teacher, works against systems of authority that garner power through singularity. Further, while the student leader population continues to be predominantly white, I interviewed individuals who identify as black, Latin@, Vietnamese, native, Laotian, and Pacific Islander, and I imagine that the diversity of cultures present within any week's cadre of

student leaders is significantly greater than that typically found in the population of teachers in public school buildings.

If it is true that the learning environments of this ODS program succeed in the performance of multiple natures, this performance is certainly not possible without the activities of human actors. The ability of the staff members to work collectively to meet the needs of an ever changing cadre of sixth graders, needs that are emotional and academic and many other things between, is truly astonishing. At the same time, staff members also succeeded in performing their own unique versions of ODS within the larger whole of the program. This is due in part to the fact that staff member have fairly unique roles within the organization of the program as a whole, but also because they have unique personalities, and ways of interacting with both students and the environments around them. And while students experienced bits and pieces of many of the staff members during as the week progressed, they could also gravitate towards the individual who performed the version of ODS that was most compelling to them at the time. Further, if each of the eleven staff members were offering distinct versions of ODS, so were the student leaders and the sixth graders. Despite the repetition of the program, no two weeks were the same, and I believe that both the performance of multiple educational realities within the same program, and the agency that the student leaders and sixth graders are invited to exercise in these performances, is one of the most unique features of this program. This is a further manifestation of ontological politics, and a hugely important force in destabilizing the authority of a single Nature.

While individual staff members were undeniably performing different realities of ODS, their interactions with one another complicate taken for granted concepts of both

reflective practice and collaboration that have become ubiquitous in conversations about teaching more generally. First, Fendler (2003) points out that the act of reflection, especially when framed as an individual practice, is likely to justify and rationalize current conditions and practices of teachers and educational institutions, rather than encouraging their critique and transformation. Indeed, the metaphor of thinking as reflection, without further clarification, seems to emphasize the problematic view of science and knowledge as representation, rather than practice. Although individual staff members occupy unique niches within the program as a whole, they are very rarely performing in the isolation typical of classroom settings, and are constantly seeking feedback from one another. Several staff members talked in interviews about the experimentation inherent in their practices, of constantly trying new things while interacting with different groups of sixth graders and student leaders, and how easily such experimentation can get lost in the constant shuffle and movement of the program. However, when such experiments are witnessed by a colleague, they get resurfaced later in conversations and debriefs, and become objects of reflection in ways not typically possible when our experimental teaching practices occur behind closed doors.

Summary and Potential Applications

Purpose and Scope

In this dissertation, I examined the shifting aims of science education, and in particular, their relationship to the ideals of social justice and democracy. I argue that the field of science education has largely pursued these ideals through increasingly reflexive attention to the relationship between the social aims of science education, and the

epistemic dimensions of science as a set of diverse practices. This reflexivity has benefitted from conversations between science education and the burgeoning field of science studies, and shows up in both research (Duschl, 2008; Van Eijck, 2012) and in the Next Generation Science Standards' shift away from the language of inquiry, and towards a discussion of interrelated science practices. These changes in research and policy are important, as they move away from describing the epistemic dimensions of science as a singular and definitive method (TSM). Further, the work of scholars like Sandra Harding (2006) demonstrates how Western Science is complicit in encoding both pro- and anti-democratic principles. Such anti-democratic principles are particularly evident in the Unity Thesis, which supposes that scientific knowledge is universal in scope and application. In addition, science education has become increasingly multicultural, and scholars like Lee & Buxton (2010), and Van Eijck & Roth (2007) explore how the diverse cultural backgrounds and epistemic practices of students can both afford and constrain the learning of mainstream science.

Accordingly, science education framed solely in terms of the transmission of content has been deeply troubled, and scholars have sought to redefine the aim of scientific literacy, recognizing that transmitting facts and concepts fails to adequately address either the complex social role of science, or its epistemic heterogeneity (Van Eijck, 2012). However, I suggest that the emphasis on epistemology and multiculturalism has ignored the ontological commitments of science and science education, commitments that also have important implications regarding the relationship between science education and democracy. In order to address this lack, I turned to the ontological politics of Bruno Latour, which offers both a compelling critique of Science and its

commitment to mononaturalism, as well as a tentative direction forward: a move away from Science and towards the sciences, a move made possible a different ontological commitment: multinaturalism. And, continuing to draw inspiration from the field of science studies, I have engaged in a case study of sorts, asking how the practices endemic to a residential outdoor education program can provide resources for further articulating how we might reorient science education towards the positive aim of a multinatural and emergent scientific literacy.

In this final chapter, I have attempted to build a more robust theory of multinatural scientific literacy. I hoped to demonstrate how my own well-intentioned practices of classroom science teaching often unwittingly continued to emphasize a single nature, while at the same time pointing to particular aspects of this ODS program that performed multiple natures towards which learning and teaching could be directed. Finally, I hope that this project demonstrates the utility of developing frameworks across the academic disciplines that engage in the work of teaching towards justice and democracy in nuanced and particular ways. And while I often dream of educational systems that are no longer beholden to the strange organization of academic disciplines, in the meantime I encourage educational researchers and practitioners across areas of study to inquire into the specific ways that traditional subjects intersect with the work of justice and democracy.

This is also to extend the conversation that Law's (2008) work initiates between the fields of STS and sociology into the realm of education. I argue that the sociology of education can benefit from an increased engagement with the methodological offerings of STS, and in particular the use of case study analysis to engage in ontological politics.

While the sociology of education has emphasized the ways in which schooling often reproduces social inequalities rather than resisting them, the premise of ontological politics moves beyond this either/ or thinking. As Duncan-Andrade & Morrell (2008) demonstrate, even while the structure of schools may promote sorting and social stratification, "[t]he paradox of educational inequality is that schools remain among the few institutions that produce opportunities to contest structural inequality" (p. 10). Such contestation requires that teachers have access to critical pedagogies that perform different possibilities for the lives of their students, and I contend that the framework of multinaturalism provides an opportunity to engage in particular and localized discussions about the a critical pedagogy of science education.

As I emphasized earlier, this work is not meant to offer a prescriptive method for teaching towards a multinatural conception of scientific literacy, but rather to provide an explanation of how this is possible, and what one version looks like in practice. As such, I begin by offering a tentative definition of multinaturalism as it pertains to this particular study. Then, I will respond to the analytical questions I offered at the end of chapter two, before turning to the question of how this ODS program might inform the possible proliferation of residential outdoor science programs across the state of Oregon.

Mutlinaturalism revisited

I began my formulation of multinaturalism with the work of Latour (2004b), following his argument that problematic authoritarian aspects of a singular Science are sustained by an ontological commitment to a single natural world. This produces two intertwined and anti-democratic tendencies: First, so long as Nature is positioned as the

source of all objective knowledge, separate from the supposedly subjective Social world, scientific knowledge will always trump other ways of knowing and being in the world. Second, when we specify a single group of individuals—Scientists in this case—as uniquely able to speak the objective Truth of Nature, we determine in advance which voices count, and which can be ignored. Even when we embrace multiculturalism, which suggests that representations of the world are plural, the world itself remains a singular foundational source of authority.

So long as we equate experience with knowing, this plurality may suffice. However, when we recognize that interactions with the world are not simply aspects of knowing and cognition, and that experience, in the sense of Deweyan Pragmatism, is a much broader engagement with the world, then pluaralizing the knowledge aspect alone is insufficient. Accordingly, the move to multinaturalism is also an effort to move towards the ontological plurality necessary for us to avoid evaluating experiences on the basis of their commensurability with a single known world. As I describe in greater detail in chapter three, this shift does not simply replace the authority of nature with that of experience. Instead, it changes the emphasis from evaluating experiences against a single Truth, and towards a valuation of experiences according to the consequences they produce when guiding future actions and practices.

Accordingly, a multinatural science education recognizes a plurality of modes of existence, where referential knowledge is but one aspect, albeit a tremendously important one. It also provides a different starting point for dealing more productively with the inevitable conflicts between theory and experience. The histories of the sciences and the natures they purport to study are replete with examples of this productive tension. The

point of multinaturalism is not to solve this tension, but rather to sustain it, and I hope that the stories I tell here offer examples of what it looks like to embrace this tension through both pedagogy and curriculum.

What types of curricular and pedagogical practices enact this definition of scientific literacy?

In general, my claim is that ODS offers a unique opportunity to think about how both learning and teaching in science education can be reconfigured towards the aim of a multinatural scientific literacy. As I suggested towards the end of chapter three, I understand this ODS program as a being of metamorphosis, one that enables learners to enter into new relationships with one another, and with the ontology of nature and its relationship to science. This reconfiguration involves different approaches to science curriculum and pedagogy, and as such, reimagines the relationship between teacher and learner, as well as the relationship between sciences and nature(s).

First, in terms of curriculum and pedagogy, ODS reminds that collective action is not simply something that emerges once the problematic individualism of classroom culture, with emphases on testing and individual accountability, is removed. Instead, collective action must be taught. Second, it demonstrates how experimental work can be framed as learning how to converse with plural natures, rather than divining the Truth from a singular Nature. This involves both a troubling of the categories of science through a science studies type approach (the solar powered sea slug and the problems with purified categories and a messy world), as well as a greater respect for experiences with natures that don't reveal singular truths.

This is perhaps the most relevant place to begin imagining new curricular and pedagogical approaches to science education—that is how can science education provide more opportunities to practice navigating the tension between adherence to theory on the one hand, and remaining open to anomalous experiences on the other? We teach students that science is an empirical process of inquiry, and yet I wonder how and when we as science educators encourage students to delve into the complex relationships between theory and empirical observations that drive the production of scientific knowledge. I argue that such work requires science educators to historicize both science *and* nature; students must understand both the rhizomatic unfolding of scientific knowledge as it intersects with politics, social norms, and technology, as well as the idea that nature is also perspectival and historical. This, perhaps, is to follow Dewey's urging that we become Darwinian at last (1973a), reminding us that humans, too, are of and situated in emergent natural worlds, where articulations of both good and truth are interdependent, perspectival, and constantly in flux.

How does this ODS program offer insights about what preparation and support science educators need in order to teach a scientific literacy that is collective and multinatural? That is, what types of practices encourage and enable future science educators to teach towards a conception of scientific literacy that is collective and multinatural?

Teaching towards a multinatural and emergent conception of scientific literacy requires shifts in both curriculum and pedagogy, and both offer interesting implications for how we recruit and educate future science teachers. Because a mononatural ontology

of nature is deeply entangled with authority, requiring attempts to secure a single interpretation against experiences that are plural, the relationships between learners, teachers, and the natures under investigation all come to matter in important ways. Without an authoritative teacher to play the role of Scientist, to remind students of the stable nature their Science should reveal, the specter of right answers and single truths dissipated. Instead, the multiplicity of educators, including staff members, student leaders, and the sixth graders themselves, all of whom contribute to the learning and teaching in this program, perform multiple versions of ODS that cannot be fixed or finalized. This too supports the practicing of plural sciences, and further enables an orientation that supports multinaturalism.

I often wonder how the requirement that science educators first earn undergraduate degrees in STEM fields contributes to this problem with authority. In other words, before someone can begin training as a science educator, they must first prove themselves within a system of undergraduate science education that rarely asks students to question the authoritative nature of Science. Indeed, this authority is all too easy to embrace without question, and if the success of these individuals stemmed largely from their ability to respect the authority of science, it is difficult to imagine them developing practices of science that call such authority into question. Accordingly, I suggest that programs like ODS offer the possibility of alternative pathways towards becoming science educators. Many of the staff members were themselves sixth graders and student leaders with the program, and have remained in this alternative educational space precisely because they themselves experienced traditional forms of schooling as problematic at best, and oppressive at worst. They carry these experiences with them in

their daily practices, explicitly seeking to excite learners who, like themselves, are often bored and uninspired in traditional classroom settings. On the one hand, I don't want to suggest that these educators would matter more if they were to move into more traditional schools and teaching jobs, as this ignores the important work they are currently performing. On the other, I think that this setting provides important opportunities for preparing science educators, and universities and departments of education might begin to imagine how this work can also be honored and included among other efforts at developing a future cadre of science educators. For too long we have imagined that science educators themselves need to be scientists, or at least to apprentice with practicing scientists (see Lotter, Harwood, & Bonner, 2006; 2007). Instead, I am tempted to make the strange claim that the field of science education is in need of more non-Scientists, especially when Scientists themselves are associated with singular and authoritarian conceptions of Science and Nature.

Applications and Limitations

While I am loathe to suggest that the practices of this ODS be used as a prescription for science teaching and learning more generally, I do believe that this program should be used as a model for the development of similar experiences. This November, voters in the state of Oregon will consider ballot measure 67, which would provide funding for a six-day and five-night residential outdoor education experience for all sixth graders across the state. If this measure passes, local districts will be charged with designing and structuring their own versions of Outdoor School. And while the curricular specifics can and should change to reflect the multiple unique environments

found across the state, I argue that many of the programmatic aspects of the MESD ODS that I have outlined in this chapter can and should be emphasized as resources. And while the curricular materials that have been developed by this ODS can be packaged and transmitted to the developers of new programs, I argue that the stories I tell in this dissertation help to demonstrate that the teaching and learning that is unique to this program is far greater than the sum of its curriculum and lesson plans. Instead, it involves a unique educational space where collectives of teachers and learners are able to simultaneously perform multiple realities of science education, a multiplicity that better serves the needs of diverse learners, and supports the connection between science education and democratic action more broadly.

As such, there is still much work to be done in terms of interrogating how the work of teaching towards multinaturalism intersects with the particulars of difference. Indeed, my methodological choice of crafting composite fictionalized narratives limited imposed limitations on the differences these stories were able to evoke. I want to emphasize that the disembodied nature of the characters that populate these stories sits in tension with my belief that in all interactions, and perhaps teaching and learning in particular, bodies matter. And in the individual instances that these stories draw from, bodies did matter, as did categories of race and class and gender and ability and sexuality and religion and nationality. Additional work is required to flesh out more fully how a multinatural science education intersects with different forms of embodied and cognitive diversity. Just as Finney's (2013) work explores the particular intersections between nature and the lived experiences of African Americans, additional analyses that surface the way that nature is also entangled with categories of gender, sexuality, nationhood,

wealth, religion, will be necessary to continue to explore the particular ways that a multinatural science education works against the oppressive tendencies of science and education more broadly. Further, there are many instances in both the stories I have told here, and in my field notes and interviews in general, where topics of race, gender, sexuality, and other categories of identity were explicit. I hope in future work to bring greater analytical precision to these topics, in addition to thinking about projects of inquiry where such topics are given greater analytical focus. For example, the interactions between the newly arrived sixth grade students are conspicuous in their lack of attention to gender; while students are reminded of the importance of hydration, and of paying attention to their bodies, the fact that the bodies of sixth grade girls are in a particularly precarious state of flux remains unsaid. Further, as stated in the stories, my own body led me to spend much more time in the boys' cabin area then in the girls, and I wonder how the stories I tell might have emerged differently had I conducted this research project as a team, with researchers embodying various intersections of gender, race, sexuality, and ability, in order to gain access to experiences and locations that were precluded by my the particulars of my physical presence.

I also want to recognize that the scope of this dissertation is decidedly small. While I have begun the work of fleshing out multinaturalism as an orienting principle for versions of science education that are more equitable, democratic, and less in conflict with plural experiences of worlds always in the process of becoming, this inquiry project has many more limitations that concrete implications. Perhaps most notable among these limitations is the lack of data pertaining to the sixth grade learners themselves. In order to offer definite conclusions about the ability of this ODS program to better meet the

needs of diverse learners, I would need to design a very different research project, one that would likely require me to observe students learning science both at ODS and in their traditional school settings. I have also provided no measures of learning, nor have I followed sixth graders after their ODS experiences to find out if and how these experiences continue to inform their science learning in general. Further, that I have not followed these lines of inquiry does not mark them as less important; they simply are not within the scope of the study I describe here in these pages. Instead, I hope they may inform future studies of both this particular ODS program, and other examples of non-traditional science learning in general.

I also believe that there are important limitations in my theoretical and methodological orientations. On the one hand, turning to the field of science studies to address science education feels like a compelling and defensible choice; science studies has developed unique critical perspectives for thinking about the relationship between science and human activity, while also holding onto the belief that the sciences themselves are not so entangled with oppressive and anti-democratic tendencies that they should be abandoned entirely. I don't believe that such an abandonment is either possible or advisable given just how tightly the sciences are woven into our daily lives; at the same time, I think there is a tendency within science studies to hold onto romantic conceptions of the sciences, to argue that they can and should inform our democratic societies if only we can first address particular defects like the unity thesis and an underlying ontology of mononaturalism. So on the other hand, I wonder how the framework of science studies may continue to perpetuate this subtle belief that the sciences alone hold the key to societies' salvation.

Related to this concern, I worry that science studies too easily colonizes and assimilates findings from diverse theoretical perspectives without always honoring those influences. For example, before stumbling upon Latour's (2004a) *Politics of Nature*, I had imagined crafting my own theoretical framework for thinking about science's problematic relationship with democracy by reading the work of John Dewey diffractively (Barad, 2007) through more contemporary critical resources from traditions of feminist thought and indigenous philosophy. This, I now believe, is the work of a dissertation project on its own, and as such, Latour is both a compelling and convenient source to draw from as he explicitly investigates the relationship between themes like the sciences and democracy, themes that are central to my inquiry project. However, while Latour acknowledges that his move to multinaturalism draws on diverse resources from science studies, ecology movements, and comparative anthropology, he doesn't explicitly recognize the influence of non-Western thinkers or feminists in general. As Chang (2009) notes, drawing from the work of Richard Delgado, our citations are also a form of politics, and no less ontological than those I describe in this dissertation. Accordingly, I struggle with the convenience of Latour, and while his influence on my thinking is clear throughout this work, I want to at least acknowledge the continuing problematic relationship between science and the continuing centrality of the scholarship of white males, a relationship I have failed to adequately trouble here.

Appendix: Interview protocols

Student Leader Focus Group Protocol

All interviews will be directed at the following eight questions. The individual protocols that follow will also list possible probing questions that I may use to generate more explicit responses as needed.

I. Let's begin with introductions. Please tell me your Outdoor School name, and a short description of the experiences you have had with this ODS program.

II. Now that I know a little about you, I'd like you to think back to when you first decided to work/ volunteer as an ODS staff member/ high school student leader. Tell me about what drew you to this program, and for those that are returners, what keeps you coming back.

III. Next, I'd like to talk about the ways that the ODS program addresses the aims of science learning, community building, and leadership development. Let's talk about the science learning portion first.

Describe the science learning that takes place at ODS, and your role in that teaching and learning.

IV. Now, let's talk about the work that ODS does to promote community building. Tell me about the community building that takes place here, and the role you play in facilitating this work with student leaders and sixth graders.

V. Finally, let's talk about the work that ODS does to develop leadership. Tell me about the leadership development that occurs at ODS, and the role you play in developing leadership among staff and participants

VI. In talking about the work that ODS does to promote science learning, community building, and leadership development, did you feel that anything was missing from the conversation? In other words, is there additional work that ODS does that we haven't yet discussed?

VII. [Focus groups only] In listening to the words of your peers, did anything surprise you? How does ODS work differently for different people?

VIII. How do you think ODS has shaped you, and how have you shaped ODS?

Individual and Group Staff Interview Protocol

[Adapted from Cohoon, J., 2001]

Good afternoon/evening. Thank you for taking the time to contribute to my research into how Outdoor School (ODS) works, and the important role that you as a staff member play.

I want to talk with you about your experiences as a staff member, and how you understand the work this program does to promote science learning, community building, and leadership development. I will be asking about what originally led you to work with this program, and your experiences as a staff member.

Before we begin, let me suggest some things to make our discussion more productive. Because we'll be recording for an accurate record, it is important that you speak up and speak slowly. I don't want to miss any of your comments.

I also ask that you use your Outdoor School name, and refer to other staff using Outdoor School names only. No written reports of these discussions will link what you said with your real name or your Outdoor School name. In this way, I will maintain your confidentiality. In addition, I ask that you also respect the confidentiality of everyone here. Please don't repeat who said what when you leave this room.

If it is OK with you, we will turn on the recorder and start now.

Date of session:_____

Recording label:_____

Note: Roman numerals indicate different strands of questions, with the lettered lists showing possible probing questions that I will use to encourage conversations.

I. Let's begin with introductions. Please tell me your Outdoor School name, and a short description of the jobs you have had with this ODS program.

II. Now that I know a little about you, I'd like you to think back to when you first decided to work as an ODS staff member.

A. What was it that drew you to this program?
B. For those of you who have worked multiple sessions, what keeps you coming back?
C. How would you describe the work of ODS to a peer who was interested in becoming a staff member?

III. Next, I'd like to talk about the ways that the ODS program addresses the aims of science learning, community building, and leadership development. Let's talk about the science learning portion first.

A. Describe the science learning that takes place at ODS.
B. Is the science learning that occurs at ODS different from the science learning you have experienced in other school settings? If so, how?
C. What role do you as staff members play in the science teaching here at ODS?
D. What role do student leaders play in the science teaching here at ODS? How do you support this work?
E. What are some of the successes you have experienced with teaching science here at ODS?
F. What are some of the obstacles you have experienced with teaching science here at ODS?
G. What have you learned about science teaching and learning from your experiences here at ODS?

IV. Now, let's talk about the work that ODS does to promote community building.

A. Describe the community building that takes place at ODS. Do you have any experiences with community building in other settings? If so, how are the efforts at building community here at ODS different?
B. What role do you as staff members play in building community here at ODS?
C. What role do student leaders play in the community building here at ODS? How do you support this work?
D. What are some of the successes you have experienced with building community here at ODS?
E. What are some of the obstacles you have experienced with building community here at ODS?
F. What have you learned about community building from your experiences here at ODS?

V. Finally, let's talk about the work that ODS does to develop leadership.

A. Describe the different types of leadership development you have experienced at ODS.
B. Do you have any experiences with leadership development in other settings? If so, how are the efforts at leadership development here at ODS different?
C. What role do you as staff members play in leadership development here at ODS?
D. What role do student leaders play in leadership development here at ODS? How do you support this work?
E. What are some of the successes you have experienced with leadership development here at ODS?
F. What are some of the obstacles you have experienced with leadership development here at ODS?

G. What have you learned about leadership development from your experiences here at ODS?

VI. In talking about the work that ODS does to promote science learning, community building, and leadership development, did you feel that anything was missing from the conversation? In other words, is there additional work that ODS does that we haven't yet discussed?

VII. How do you think ODS has shaped you, and how have you shaped ODS?

A. How has ODS impacted your identity?
B. How has your identity impacted the work of ODS?

VIII. Any final thoughts or comments?

Thank you very much for taking the time to participate in this discussion. Please feel free to contact me at any time with any additional questions or concerns, and remember that the conversation we had today should remain confidential.

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